ELECTRICAL ENGINEERING

APRIL 1957
Vol. 76, No. 4

Published monthly by American Institute of Electrical Engineers

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Listen, friends, to the hideous fate of the man who learned about cables too late

Lucius K. Watt was an engineer
He was eager and honest and able,
And one of the things he did for his firm
Was to buy electrical cable.

Now he knew all the people at Okonite
But with orders he'd seldom reward 'em,
"Because," he would state, "the cables are great
But who in the world can afford 'em?"

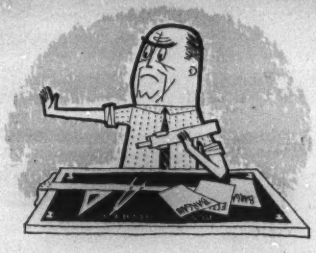
(Now that was a fault of the late Lucius K's—
That he had such a silly illusion;
For Okonite insulates cables *all* ways:
Strip, taping, dip and extrusion.

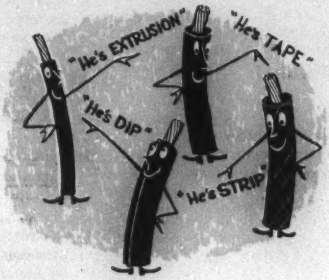
Only Okonite uses all methods, you see—
Our prices are *not* always highest;
And thus when you ask us what cable to use
Our recommendation's unbiased.)

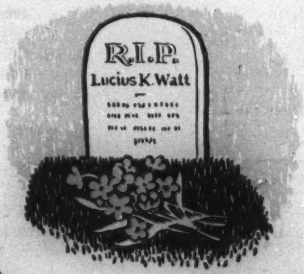
So Lucius K. Watt went out and he bought
A cable he heard was a bargain
And this was too bad, for Lucius was had . . .
By some Madison Avenue jargon.

The thing was installed (with a minor defect)
In a most inaccessible place;
When Lucius K. Watt went out to inspect . . .
The cable blew up in his face!

We hate to relate this horrible fable
But here is the moral for all:
If you should desire a superior cable—
By extrusion or strip . . . by taping or dip
Just write us a letter, or call.







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Statements and opinions given in articles appearing in *ELECTRICAL ENGINEERING* are expressions of contributors, for which the Institute assumes no responsibility. Correspondence is invited on controversial matters. Published monthly by the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Founded 1884

Headquarters, 10th floor • Editorial Offices, 6th floor

33 West 39th Street, New York 18, N. Y.

M. S. COOVER, President N. S. HIBSHMAN, Secretary

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ELECTRICAL ENGINEERING. Published monthly by the American Institute of Electrical Engineers; publication office Hildreth Press, Bristol, Conn. Editorial and advertising offices 33 West 39th Street, New York 18, N. Y. Subscription $12 per year plus extra postage charge to all countries to which second-class postage rate does not apply; single copy $1.50. Entered as second-class matter at the Post Office, Bristol, Conn., under the Act of Congress of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. April 1957. Vol. 76, No. 4. Number of copies of this issue 66,500.

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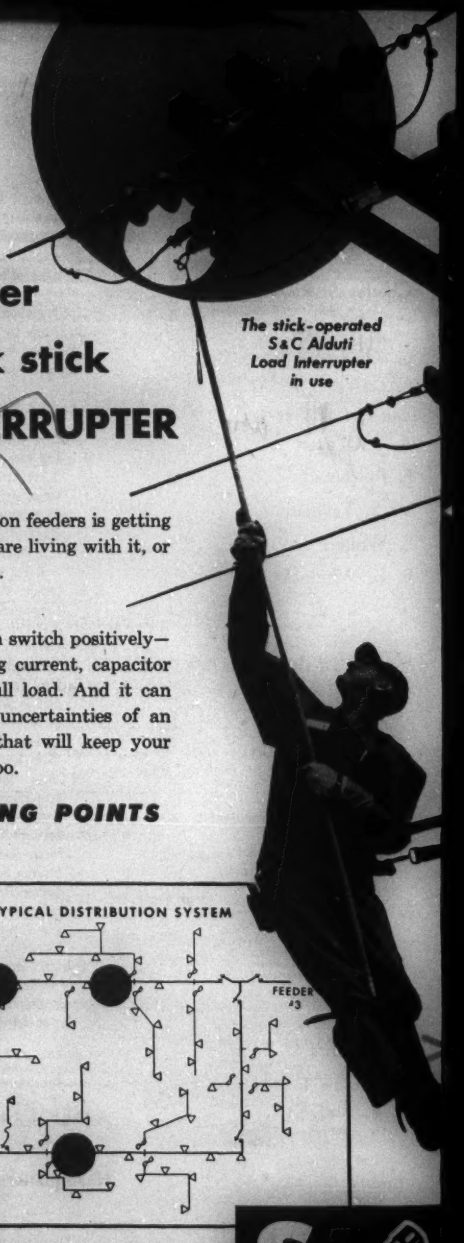

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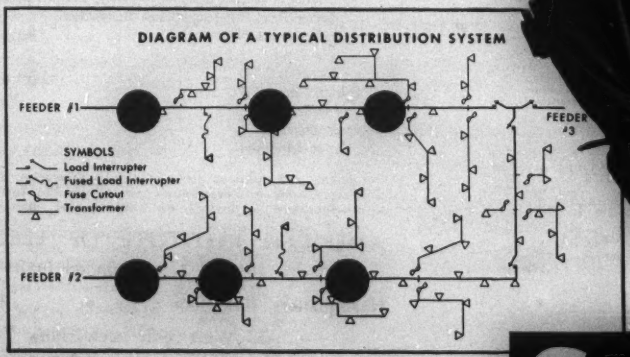

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Three-Dimensional Engineers

F. R. KAPPEL

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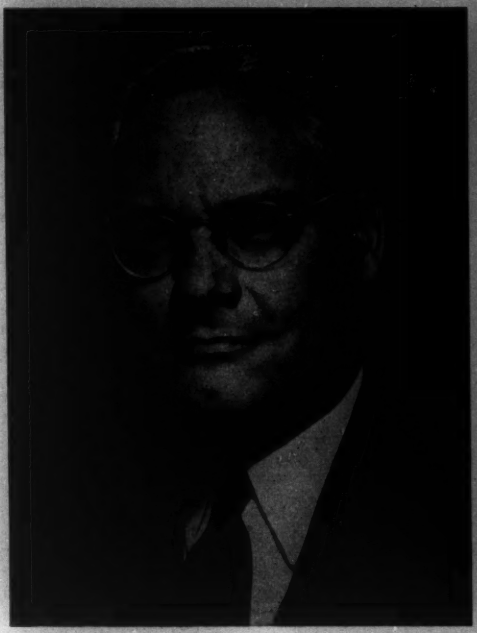


Rapid changes in the field of electrical engineering have set a pace of progress that calls for competent engineers that can grow and change with the times. Industry has the responsibility not only to provide training, but also to make sure that the able engineer never gets locked in a technical closet.

IT IS AN HONOR to be here and I thank you for inviting me.

I have always put very high value on being a member of the AIEE, and it seems like a long time since I spoke at Section meetings on inductive co-ordination, joint use of poles, power line fault currents, and once on overseas radio-telephony.

The other day I was told of a certain college president who was invited to talk to a women's club. He said all right, what would they like him to talk about? The ladies replied, "We would like you to tell us your seven greatest thoughts."

I never did find out what his thoughts were, but mine today, as you might suspect, are all about engineers and engineering. This seems to be a popular subject these days. In fact, I notice in the program for this week that at least seven other speeches or papers will discuss it in one way or another.

But I will keep the number of my thoughts short of seven. That is too many following lunch. I will stick to three and lay them all out on the table right now.

First, I have the greatest possible admiration for what our engineers have done to help make life better for more and more people.

Second, these changing times ask more of engineers and need more from engineers. Of this I have no doubt at all.

Full text of an address presented at the General Session of the AIEE Winter General Meeting held at the Hotel Statler January 21, 1957, New York, N. Y.

F. R. Kappel is president of the American Telephone and Telegraph Company, New York, N. Y.

Third, what are we going to do about it? How are we changing to meet the need? I would like to expose my notions on that.

PAST IMPROVEMENTS

ON THE FIRST POINT, just in this last generation—in the past 25 or 30 years—engineers have helped this country to improve its standard of living in a way that has never before happened anywhere. This, notwithstanding World War II, Korea, and all the burden of defense we bear today.

Probably there is no single measure to express this. However, you can sum up a great deal this way: Since the early 1920's, production per man-hour of work in private industry has just about doubled. Along with this, and because of it, although population and employment both have risen only about one third since 1929, our gross national product has more than doubled. But the big pay-off is that American average disposable income in constant dollars and after taxes—has gone up well over 50%.

And, in recent years, something has come about in the United States that tells the same story in a different way. For the first time in history, the men and women of this country are devoting more hours to providing services than they now spend to produce goods.

We spend more time flying airplanes, hauling freight cars, distributing power, handling telephone calls, keeping store, lending money, taking care of the sick, making and showing movies, washing windshields, producing

television programs, teaching school, and performing thousands of other services, than we spend to grow food, make steel, produce oil, weave cloth, dig in mines, build houses, make automobiles, and turn out all the other products of manufacturing industry.

This in itself is a remarkable measure of what science and engineering have helped to bring about. Needless to say, the vast growth in service employment tells a story of millions of new jobs created. That is almost by definition. But my point simply is that we have come very far in enabling people to live beyond the limits of necessity. And, I repeat—for the contribution you and other engineers have made to this—I have the greatest admiration.

However, that is enough about the past. The responsibilities now converging on the engineer are greater than ever before. As I have said, the times we live in ask more of us and need more from us.

You do not need to hear again from me about the race with the Soviet Union. That concerns me as much as it does you, but there are plenty of other things to be working at right on our own front porch.

POPULATION DEMANDS

For instance, take the way our population is increasing. We are growing at the rate of nearly 3 million persons a year. Most important, however, we shall have a continually rising proportion of older people who have finished their working years, and also, for the next decade, a larger proportion of young people below working age. This means that a relatively smaller working group will have to support a much bigger nation.

If we expect to do this in the style to which Americans have become accustomed—and also I hope push the standard of living higher—we have a real job on our hands. And if, on top of this or along with it, we are to give economic aid and comfort to other parts of the world to keep them with us and not against us—well, we may as well face it: the job is gigantic!

The fact is that technological progress is not something that we can just look forward to with pleasant anticipation. It is a necessity. We have to have it because we shall have to produce more, and as I said, there will be relatively fewer people of working age. We cannot just dream about shorter and shorter and shorter hours. We need to work and work hard, and we also need more and better tools, more mechanization, more plant and equipment that will do more work for us. And it is already coming home to us what this means in increased capital investment.

TECHNOLOGICAL INVESTMENTS

In the Bell System alone we expect to invest $2.5 billion this year in new telephones, cables, radio relay systems, central offices, and other equipment. For all industry, estimates vary, but I saw one forecast the other day that industry would lay out $40 billion for new plant and equipment in 1957, and that the annual outlay would pass $55 billion by 1965.

And who will see to it that all this money is wisely spent? To a very considerable extent, it must be the engineer. He is the architect of industry who must make sure that this huge investment will really produce—meaning, of course, produce at a profit.

And as he works at the job, the technical resources he is working with, and also the needs of people, are constantly changing.

On the technical side, take the changes in telephone transmission as just one example. It began on open wire lines, then went on to transmission over pairs of wire in cables. Cable carrier systems began about 1938, and soon afterward came coaxial cables.

Next came microwave radio systems, and later, over-the-horizon radio. To build them, the engineer now has available klystrons, traveling-wave tubes, magnetrons, silicon diodes, coaxial lines and wave guides, resonators and filters, and antennas.

Meanwhile, other carrier systems continue to multiply. One of the latest, designed for rural telephone lines, uses transistors and has been tested successfully with a solar battery supplying power.

This year, we expect to try out a new pulse transmission carrier system with repeaters using transistors and other miniature apparatus.

In my own engineering experience, I have seen the maximum facility for telephone transmission change from three channels over a four-wire phantom group to a 14,000-circuit microwave system that is now under development, with the possibility of a 400,000-channel wave guide system coming along in the future.

As systems multiply, and we learn new arts and new applications, components keep multiplying also. By the end of this year for example, we expect to have more vacuum tubes working at the bottom of the sea than we had in the whole Bell System in 1920. In 1930, about 85 different kinds of vacuum tubes were available. Now there are more than 1,400. The transistor, invented by Doctors Brattain, Shockley, and Bardeen of Bell Laboratories, was first announced in 1948. Today more than 180 varieties are commercially available.

I have given just a few illustrations of rapid change in a field with which I happen to be familiar. We all know the same thing is going on in every field of engineering. Science is opening up new ways to live, new ways to work, and new ways to travel on wheels or fly in the air. We are learning new ways to communicate, compute, control, and produce. We have new sources of power still in their infancy, and a great need to cause them to grow. We organize new systems out of new devices, and new devices out of new materials, and we deal with the subatomic particles of elements which formerly did not even exist, at least to our knowledge.

PACE OF PROGRESS

Anyone who has any doubt about the pace of engineering progress could remove it pretty quickly, I think, just by glancing through the technical program for this meeting. To mention only one example, who would have fore-

told a few years ago that this program in 1957 would include papers on earth satellite communications and earth satellite telemetering?

This brings me to the main point I want to make, which is that in this dynamic and expanding world the competent engineer has to lead a dynamic and expanding life. In my judgment there is simply no room left for any routine approaches to engineering, or for standing still with the mental equipment we have. The engineer has to grow and change with the times, and constantly equip himself to handle new problems. He has to nourish his mind and broaden his outlook to make sure that neither gets obsolete. And, at all times, he has to look ahead.

Obviously we need the most in creative imagination, ability to take on new assignments, and selective judgment. I think the growing tendency in the schools to concentrate on fundamentals is very helpful to this, because the first need is to develop the basic mental equipment. There remains to industry the great responsibility not only to provide first-rate technical training, but also to make sure that the able engineer never gets locked in his own technical closet.

To be sure, he always remains an engineer, with a sound grasp of engineering fundamentals that never grow obsolete. But he also becomes something more. As he applies ever-changing arts he is also thoughtful of their effects. He gains and uses knowledge of marketing and finance. He interprets between designer and salesman. He perceives and understands the general needs and particular problems of other people, whether he holds a supervisory position or not.

For such engineers I am quite sure the rewards will be ample—and I mean in money as well as in the sense of accomplishment. And, as I indicated, for people of ability who have a real proprietary interest in the business in which they are engaged and want to make their interest effective in action, industry must certainly provide full opportunity for education and growth.

TRAINING PROGRAMS

To illustrate what I mean, let me give you just a thumbnail outline of some of the educational activities we are organizing in Western Electric, Bell Telephone Laboratories, and the operating telephone companies.

The communication development training program at the Laboratories, or CDT for short, is well known. It began in 1948 in response to the need to prepare graduate engineers for research and development work. The program extends over three years with about half the time in classroom work. More than a hundred men enter CDT each year.

Starting in 1956 a small number of CDT students are being awarded fellowships to allow them to study for their doctorates. While doing this, they continue as employees at full salary.

About 140 professional members of the Laboratories are doing graduate work at nearby universities during part of their working hours, with tuition refunded by the Laboratories. For technical aides and also for engineers, the Laboratories also conduct numerous out-of-hour courses. Participation is voluntary and we expect some 1,500 registrations this year. In addition, a monthly lecture program has an average attendance of about 700.

The operating companies of the Bell System are also moving to broaden their training.

Several of the companies have organized specific courses for engineers of from 1 to 12 weeks. One course, for instance, relates engineering to the over-all activity of the company. Another is on transmission. Others cover tariffs and rates, technical writing, the work of other engineering groups in the company, reasons behind the operations of other branches of the business, and so on.

In September 1956, about 50 graduate engineers of the operating companies began 22 months of class work and study at Bell Laboratories to get a basic understanding of new telephone art, including electronic switching. We are just at the beginning of a gradual transformation of the Bell System's physical plant. In each company, we shall have to have engineers who will take leadership in effecting this physical transformation, and also in training other engineers. This is the first step in a continuing program to that end.

EXTENDING ENGINEERING EDUCATION

In general, I would say we were in the early stages of extending engineering education in the operating telephone companies. Much more is being organized right now, and the program that is taking shape in Western Electric may also be considered typical of efforts in the operating companies as well.

By late Summer, Western Electric will have three study centers, in New York, N.Y.; Chicago, Ill.; and Winston-Salem, N.C. Here both new and experienced engineering employees will be enrolled. New engineers, after their first four to six months with the company, will take a series of introductory courses to help them move into a full assignment. After a year's service they will have 10 weeks more of study and discussion, not only on technical subjects, but also in dealing with people. For experienced engineers, there will be a wide variety of advanced courses. In addition, Western Electric now operates a plan to encourage employees to study on their own time at accredited colleges. The company will refund up to $250 a year tuition to any employee, part on enrollment and the rest on successful completion of courses which the company feels are related to the employee's present job, or to a job he might reasonably aspire to hold.

Throughout the Bell System, engineers are also participating fully in management development programs. We want engineers and other management people to think out problems together.

When we started our executive conference at Asbury Park, N. J., 2½ years ago we had several ideas in mind. We wanted to bring telephone management people and top-flight men in other fields together for discussion and case study, and to let the sparks fly. We wanted the least teaching in the sense of prescribing, and the most learning through one's own thinking. We hoped, too, that the

Asbury Park idea would spread all through the Bell System at different levels of management.

All these things are taking place. And we shall encourage them more, not less. Indeed, we must.

Over the next 10 years we foresee that more than 80,000 Bell System people—engineers included—will be moving into new positions in management. In the same 10 years, we shall be going a long, long way in the transformation of our physical telephone system. New art and new applications will bring new convenience in service and new forms of service. In fact, we expect the time is coming when we will be able to communicate anything you want in just about any way you want, and over any distance, long or short. With people changing, management changing, technology changing, and service changing, it is unthinkable not to use every means in our power to improve our competence and, at the same time, our understanding of the world around us and our place in it.

You will forgive me I hope for talking so much about the Bell System. But I think our need for engineers of ability and imagination is typical. We all need them like grass needs rain. And I think we can make rain.

We will not do it by just tagging or labeling people as engineers. We will not do it by putting engineers into compartments and shutting them off from the rest of the ship. We will not do it by cramming size 42 men into size 36 jobs, or vice versa. We will not do it by setting so-called minimum standards and then sitting back and letting nature take its course.

THE THREE DIMENSIONS

We will do it, I believe, through intelligent and concerted effort to develop what I call three-dimensional engineers.

The first dimension we can say is what you got in college, that showed you how to move in a straight line in your first particular field.

The second dimension is in continued training and self-study, that broadens a man—or a woman—and keeps him up to date with technological changes so he can solve problems in broad areas and new areas of engineering.

The third dimension is the height that comes from the mixing and mingling of engineering and management ideas, so that the engineer's understanding of the problems and requirements of the business makes him more effective in the business. This understanding comes not only from study but also from shoulder-to-shoulder association and contact and interaction between engineering, operating, financial, and merchandising people. And we need this third dimension not here and there among engineers but everywhere—so they will have a volume effect on the business. If engineering is to be solid, it has got to have this volume.

As I have tried to indicate, I think industry can contribute much, especially to the second and third dimensions. Right now in our business, because of the effort we are making in these directions, we are getting a wonderful amount of fine engineering work done that otherwise could never have been done as soon or as well. More than that, with a wider appreciation by other people in management of the engineer's contribution, I am confident we are getting a better team and a better over-all job. And I am equally confident that our engineers are profiting in prestige, promotion, and salary rewards as a result.

CONCLUSIONS

As the need for technology increases further—and it surely will—it seems to me inevitable that the need for engineers in management including top management will likewise continue to increase. I do not see how it can be otherwise. What this means simply is that engineers must grow and, of course, it is they themselves who must do the growing. No one else can do it for them. The training and education I have been talking about are essential, all right, but what they add up to in the end is only the soil to grow in.

Knowing engineers as I do, and I have lived and worked with them all my life, I can only say there is no group I would sooner trust to respond to whatever challenge. As I see it, the challenge to engineers today is that they should deliberately work to fill out all the height, all the depth, and all the breadth they can reach. Along with this, industry is equally challenged to give able engineers full opportunity to live and work and think and create in all three dimensions. For this is the kind of engineering influence and leadership we need, and I have great faith we shall get it, to the further advantage of our United States and the world.

Motorized Passenger Loader

United Air Lines Photo

A motorized passenger-loading stand, introduced by United Air Lines at Los Angeles (Calif.) International Airport, has two electric motors with one hp each. Power consists of four 6-volt, heavy duty batteries, charged by a selenium rectifier. One motor provides forward or reverse speeds of two miles an hour, the other raises or lowers the entire structure from a low of 6 feet, 8 inches to the maximum height of 10 feet, 11 inches. It weighs 2,000 pounds and can support 7,200 pounds.

Induced A-C Losses in Steel Plates

W. G. DEURING
MEMBER AIEE

THE PROBLEM of evaluating power loss is an ever-present one in any field of electrical engineering. In many instances, the current distribution in conducting materials can be evaluated and the corresponding loss determined. In those remaining instances, the physical geometry and field configurations are such that exact analysis is not possible. Loss evaluations for those cases must be based on experience expressed empirically or analytical work modified to agree with experimental data.

Conductors in high-voltage circuits are usually so far removed from conducting surfaces and carry such low values of current that the magnetic field intensity induces no large amounts of loss in the conducting surfaces. However, the conductors in low-voltage circuits are often placed as close to grounded conducting surfaces as electrical or mechanical limitations permit. With the increased acceptance by the electrical industry of large blocks of generation and transformation kva, the problems of handling the resulting high values of current in the low-voltage circuits become more pronounced.

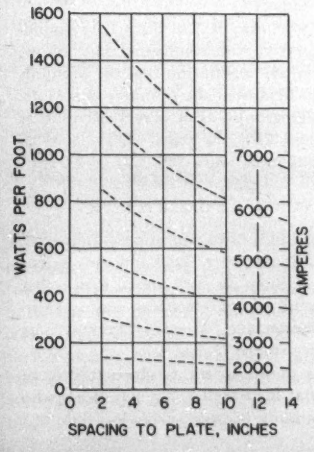
It is apparent that the complex geometrical configurations of lead structures in transformers and other electrical equipment do not permit testing the innumerable possible combinations of structures to determine the induced loss as a function of current and distance. It then becomes necessary to determine the loss in as simple and fundamental a geometry as possible and apply the results to the configuration of a particular design.

A test fixture has been built which, for practical purposes, simulates a semi-infinite solid excited by a current filament. Tests were made to determine the loss induced in the conducting, magnetically permeable semi-infinite solid at different values of current and lead-to-surface spacing. Fig. 1 indicates the magnitude of loss induced in typical hot-rolled carbon steel tank plate material.

The induced eddy-current loss in transformer tank walls is a function of tank current to some power multiplied by the resistance of the tank circuit. Inasmuch as the magnitude of the current is independent of the resistance of the circuit, lower loss will result when the resistance is reduced. A series of tests was made with the surface of the semi-infinite solid covered with 1/4-inch thick aluminum plates with 41-per-cent conductivity. Fig. 2 indicates the induced loss in the semi-infinite solid when shielded with aluminum. The induced loss in the steel aluminum-shield configuration is about 15 per cent of the induced loss in the steel configuration.

Analysis of the loss data indicates that the induced loss in the unshielded steel is a function of current to a power less than two, whereas the induced loss in the steel aluminum-shielded configuration is a function of current to a power of about two. The less-than-two exponent for the current with unshielded steel is the result of the extremely nonlinear magnetic characteristics of the steel tank plate material.[1]

The test data have been compared with an analytical approach[2] and a correlation can be obtained if a value of permeability of 10,000 cgs (centimeter-gram-second) units is assumed for steel, and 10 cgs units is assumed for the steel aluminum-shielded configuration. Both values of permeability are about 10 times as large as maximum values usually attributed to either of the materials used. A permeability of 10,000 for steel can be considered as providing for the so-called anomalous loss, and the permeability of 10 for aluminum can be considered as providing for the lack of complete shielding and the partial penetration into the steel of the exciting magnetic flux.



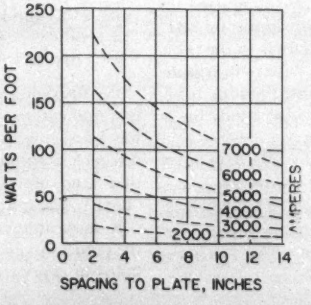


Fig. 1 (left). Loss in unshielded plates. Fig. 2 (below). Loss in shielded plates.

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Job Opinions of Engineering Seniors

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The results of an extensive questionnaire answered by 3,433 seniors and graduate students in electrical engineering of 129 colleges in March 1956 are analyzed. A whole series of challenges are posed for the engineering profession. Failure to act now can have major effects on the profession of electrical engineering in the next 10 to 20 years.

THE CONTINUING DISCUSSION about the shortage of engineers and scientists suggests that knowledge of the opinions of electrical engineering students about to graduate might contribute to a solution of the difficulty. In April 1955, Eta Kappa Nu Association sent questionnaires to 57 colleges in which it had chapters. The questionnaires were distributed to seniors and graduate students; they asked for facts and opinions about employment plans. Completed questionnaires were received from 930 students in 45 colleges. The results were analyzed by Stanford Research Institute, and presented in a report[1] entitled "Employment Plans of Electrical Engineering Graduates."

The results of the 1955 survey aroused interest among diverse groups. There were discussions of the results in meetings of national committees of several professional societies. A paper[2] based upon the data of the survey was presented to the AIEE in New York, Feb. 2, 1956. Editorial comment appeared in several professional and trade journals. Eta Kappa Nu was urged to conduct a more comprehensive survey in 1956.

In response to the last suggestion, Eta Kappa Nu Association, in co-operation with several AIEE and Institute of Radio Engineers (IRE) committees and Stanford Research Institute (SRI), prepared a new and more extensive questionnaire and submitted it to the seniors and graduate students in electrical engineering of 145 colleges in March 1956. The completed, useful questionnaires totaled 3,433; they came from students in 129 colleges.

The 1956 Eta Kappa Nu survey was also conducted by SRI. In 1955, the cost of the survey was borne by SRI. In 1956, Eta Kappa Nu asked, through letters to the presidents of nearly 120 companies, that industry contribute to the cost of the survey. Generous contributions from a large fraction of the companies provided funds for a major portion of the costs of the survey.

Copies of the final report[3] prepared by SRI have been distributed to the companies that contributed to the cost of the survey, to the colleges from which information was obtained from students, and to officers of the co-operating societies and members of sponsoring committees.

Essentially full text of a conference paper presented at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957, at a session sponsored by the AIEE Committees on Education, Student Branches, and Research.

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PURPOSE OF THE 1956 SURVEY

THE PRIMARY PURPOSE of the 1956 survey was to learn the reasons for the decisions of the members of the graduating classes regarding their employment. Information was requested regarding opinions about different kinds of business, different occupations, and the position actually accepted. Additional information was sought on many other items that might help in evaluating the strength or weakness of the engineering curricula and employers' personnel practices.

The purpose of this article is to present selected data from the Eta Kappa Nu 1956 survey, and to comment critically on a few aspects of these data.

There are seven sets of data that have been assembled from the information submitted by the students for presentation in this paper. Each set is presented in the form of a chart to facilitate a quick review of the facts and opinions offered by the students. This is followed by critical comments on the data. For details about the questionnaire and the original data, the final report may be consulted.

It should be noted at the outset that the number of respondents (3,433) is approximately equal to 50% of the total graduates in electrical engineering in 1956. This is, therefore, a very large sample; nevertheless, those who did not respond may have had opinions different from those reported in this survey.

It should be noted, also, that 91% of the 3,433 respondents were seniors. Many of the comments that follow, therefore, are based on the assumption that the opinions adduced from the data represent the opinions of seniors. The respondents by age groups, as of May 1956, were as follows: 21 years of age, 27%; 22 years, 22%; 23 to 25 years, 23%; and more than 26 years, 28%.

OPINIONS OF TECHNICAL OPPORTUNITIES

IN THIS INQUIRY, the kinds of organizations—industrial, Government, or educational—were listed and the student was asked to give his opinion *on each one* as to whether the *technical* opportunities for electrical engineers in that kind of organization are "Good," "Average," or "Poor." The results are shown in Fig. 1.

A most interesting point, which is characteristic of the entire survey, is that the number of respondents who failed to express an opinion is quite small—less than 6%

on practically all questions. Modern education in the United States is being criticized for many things; it appears, however, that when men become seniors in electrical engineering they not only have opinions, but also are willing to express them.

Although the result may not be comprehensive, it is nevertheless interesting and startling to consider in Fig. 1 just the areas of work for which the opinions as to technical opportunities are predominantly "Good" or predominantly "Poor."

Seniors believe that the opportunities for challenging technical work—and this implies increasing knowledge—are predominantly good in industries that manufacture diverse kinds of electrical equipment (including electronic equipment), in education, in industries that manufacture only electronic equipment, in consulting work which deals with electronics or communications, and particularly in research.

They think the technical opportunities are predominantly poor in electric power utilities, process industries, transportation companies, and particularly for utilities other than electrical, such as gas and water.

For other electrical manufacturing companies and for communications companies the opinions are predominantly "Fair," with relatively small votes for "Good" or "Poor."

Supplemental comments entered on the questionnaires indicated that many of the colleges and also employers have provided little information for the students regarding the kinds of work and the opportunities in certain businesses. This lack of information may largely be responsible for the poor opinions of several lines of employment.

There is in the answers to this inquiry a whole series of challenges to the profession of electrical engineering. These challenges can be put in the form of questions, of which some are the following:

1. If a large fraction of graduates wants to work on computers, solid-state devices, information theory, control, and all the other new areas under the tent of electronics, how can undergraduate students be educated to prepare them for this work? If more of the basic aspects of these subjects are put into the curricula of our schools, what will be removed to make room for them? How are the students to be educated to prepare them simultaneously to become good citizens and professional engineers?
2. What are the utilities—not just power, but others as well—to do in order to find personnel who can solve the formidable technical problems they face?
3. Is the trend of opinion represented by these data temporary in nature or will it proceed further in the direction it seems to have taken in the last 25 years?
4. What will be the actions of professional-technical societies in electrical engineering to meet the needs of their members, who are becoming active in many diverse and highly technical endeavors?
5. What is the responsibility of the colleges and employers to correct the difficulties in training the college students, informing them of the work that they may expect, and properly placing them as employees?

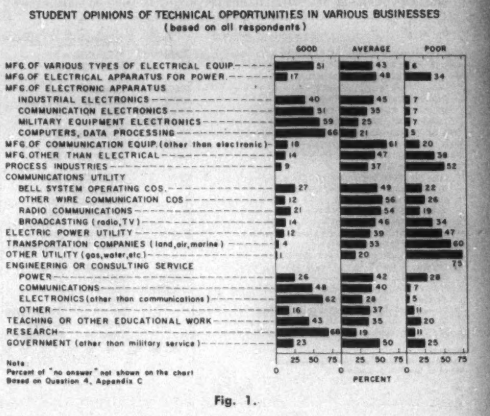


Fig. 1.

Tentative answers to some of these questions have been offered and are being tried. Failure to analyze questions like these, and failure to act soon can have major effects on the profession of electrical engineering in the next 10 to 20 years.

OPINIONS OF FINANCIAL OPPORTUNITIES

STUDENTS' ESTIMATES of financial opportunities are shown in Fig. 2 for the same activities as those listed in Fig. 1. There is a strong tendency throughout the chart to emphasize "Fair" and "Poor" opportunities, rather than "Good." The latter designation is given a majority vote only for the fields of computers, military-equipment electronics, and consulting in electronics.

In spite of this modest appraisal of financial opportunities, these students want to go into highly technical work, as is brought out further by subsequent charts. There were several voluntary comments that salaries offered to recent graduates were inadequate by comparison with those of factory production workers or plumbers.

RELATIVE INTERESTS IN KINDS OF WORK

THE AREAS in which electrical engineers most commonly work were divided into 12 categories, and respondents were asked to indicate their relative interests by marking each of the 12 categories "Great" or "Average" or "Little" (each adjective assumed to precede "relative interest"). The results are summarized in Fig. 3.

Here again the strong technical bias of students is shown. They have great interest in work that contributes to new things and ideas and, therefore, to the advancement of the science and art of engineering: development, design, research, computing, automation, and planning. These results might have been inferred tentatively from the data of Fig. 1.

Student interest is relatively slight in sales engineer-

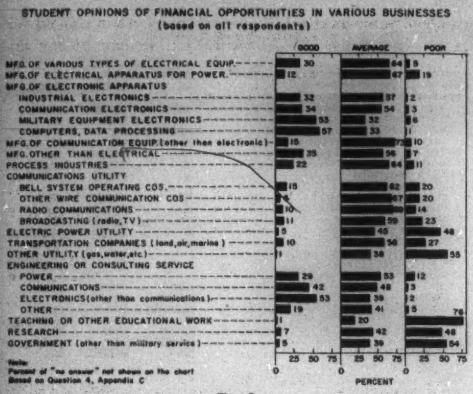


Fig. 2.

ing, construction, manufacturing, and college teaching. Because there are able engineers in these fields who show all the symptoms of enthusiastic, creative enginering, it appears that the challenges of these fields have not been presented convincingly to students.

For example, perhaps the student thinks of sales engineering as a continuous round of long and hurried trips by air; a boring and exhausting series of visits with customers with too many cocktail parties, dinners, and trips to the theater; and too many ulcers and coronary attacks. It is quite possible that the majority of students do not know of the highly technical work done earlier in their careers by men who become good sales engineers; do not know of the challenging combinations of technical and economic problems faced in an environment of stiff competition by the sales engineer; do not know either of the deep personal friendships that develop between the sales engineer and his counterpart in the organization to which he sells; or finally, the respect gained in the profession and the executive opportunities sometimes available to competent sales engineers.

Similar remarks can be made about most of the other fields that arouse little interest among seniors. With respect to university teaching, it may well be that the teachers themselves are to blame. It is now well-established folklore that college teachers are underpaid, overworked, and underprivileged. Many have been, and some are; but the engineering profession is fast achieving a position in society such that the teacher of engineering can have a most active, interesting, and rewarding career. The income may be a little less than it would be in industry, but the difference is becoming smaller. As a matter of fact, the data in the report about teachers' salaries are contradictory to the popular conception.

Only 28 students out of 1,791 reported that they had accepted teaching or other educational work jobs, but the average of the reported salaries was $448—more than the $442 which was the average for all jobs. It would thus seem that there are some well-paid starting jobs in teaching work and that the electrical engineers were quite selective in picking the better paid ones.

There are splendid opportunities for young men to study, do research, teach, take part in professional-society activities, consult, or work in the summer in industry, and achieve positions of responsibility. Perhaps professors have tended to emphasize, in their discussions with students, the worst aspects of a career in teaching, rather than a balanced statement of the advantages and the pitfalls in the development of such a career.

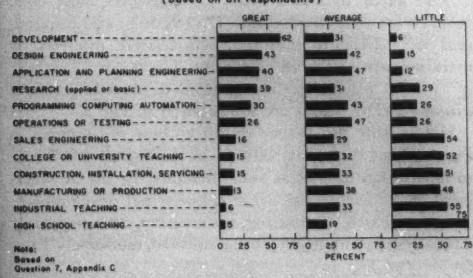


Fig. 3.

FACTORS INFLUENCING CHOICE OF EMPLOYMENT

THE RESPONDENTS were asked to list, in descending order of importance to them, a group of factors that had influenced their selection of employer or would probably influence their choice if they had not yet accepted a job. The composite results are shown in Fig. 4. The data were evaluated by assigning numerical ratings such that the highest numerical rating represents a combination of a large number of votes and high relative placement in the list.

The students chose three things which they consider most important: good opportunities for personal and professional development, work in fields of special interest to them, and work in a geographical location they like. They are not much influenced by offers of special benefits, previous experience in some kind of work, or family pressures. They show some, but not emphatic, interest in long-range security, high total income during their careers, and high starting salaries.

The data of Fig. 4 apparently show that most students are strongly motivated by considerations of individual interests, individual ambitions, and individual choice of the part of the country in which they want to live. Although starting salary comes pretty far down in the chart (Fig. 4), there is evidence in answers in other parts of the questionnaire that students are highly sensitive to relative values of salaries offered by various industries and by Government.

Students were asked how they appraised opportunities for graduate study, as a part of conditions of employment. They answered: 40%, essential; 53%, desirable, but not essential; 6%, of no importance. This distribu-

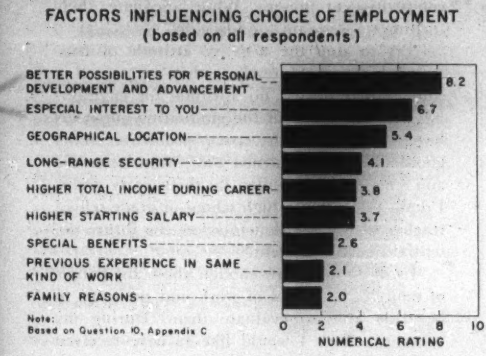


Fig. 4.

tion of opinions, in combination with preferences for jobs having to do with new devices and systems, and for work in design, development, and research may be surprising to some engineering educators. This combination of opinions shows that the philosophy of teaching undergraduates the scientific foundations of engineering and stimulating the student's desire to learn for himself is an acceptable philosophy to most graduates of 1956.

Strong interest was expressed in flexible training programs in industry; 79% of all respondents considered an initial training program a very desirable factor in job selection, and 63% of those who had accepted positions were to undergo such a training program. Very unfavorable comments were expressed by some men who thought that they had been victimized by being placed in stock-keeping and common labor jobs and at other menial tasks during so-called training programs. Several others exhibited a very selfish attitude and said training programs were just a device to innoculate the man with company policies and were of no value to him if he changed jobs. These diverse opinions show the need for better knowledge of how industry functions, of the operation of properly planned training programs, and of the part that must be performed by both employees and employers.

JOBS ACCEPTED—KINDS OF ORGANIZATION

ALL RESPONDENTS who had accepted jobs (1,791 out of the total of 3,433) were asked to list the kind of organization they planned to join. The results are shown in Fig. 5. The trends of opinion previously noted—and here transformed into action—are clear. The low fractions of students going into teaching and Government are sources of worry for all members of the profession. Again the question arises as to the sources of professional staff for the utilities.

All employers of electrical engineers should re-examine their needs for new employees. Each employer may have one or more category of work that requires men who are scientifically oriented and anxious to face new and challenging problems; other jobs may better be filled by candidates with a more general education than electrical engineering. Such an evaluation, and consequent action, might enhance the profession of electrical engineering and simultaneously provide excellent opportunities for those having a good general education but no strong scientific specialization.

JOBS ACCEPTED—AREAS OF WORK

THOSE WHO HAD ACCEPTED POSITIONS when they submitted questionnaires described the areas in which they will work as tabulated in Fig. 6. These data show clearly that there are opportunities for employment that generally satisfy the desires of the entire group, as shown in Fig. 3.

Development, design, planning and application, and research represent the vast majority of work in which the new graduates will be engaged. The total for these cate-

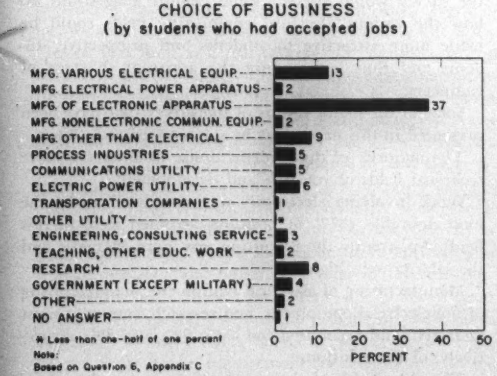


Fig. 5.

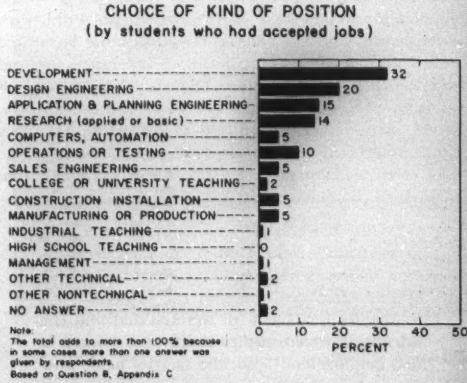


Fig. 6.

gories, from Fig. 6, is 81%. However, many students indicated that they would be engaged in at least two of the occupations. Allowing for these multiple answers, it is estimated that at least two thirds of the graduates will be employed in these four areas of work.

STARTING SALARIES

FOR THOSE who had accepted jobs, the starting salaries were listed with the kind of employer. Fig. 7 lists the average monthly salary for each kind of employer for which there were 15 or more individuals already offered employment.

The average monthly starting salary is $442. A breakdown by age and academic degree is interesting:

Degree	Average Salary (per month)
B. S. (all respondents)	$440
B. S. (23 years old, or less)	426
M. S.	491
Ph. D.*	591

* The number is small: 10.

There is a marked increase in salaries listed in the 1956 survey over salaries listed in the 1955 survey.

ADDITIONAL DATA

MANY OTHER interesting statistics and comments were revealed by the survey. Some of these are summarized in the paragraphs which follow.

Of the 3,433 respondents, 61% are members of AIEE and 51% are members of IRE; 28% belong to both societies; 24% are members of the Eta Kappa Nu and 21% of Tau Beta Pi; 14% are members of both honor societies.

Many students expressed a desire for summer work, co-operative work and study programs, or other means of obtaining some practical experience in their chosen profession. Seemingly, in many parts of the country, there is little opportunity for such employment. The result: many students very close to graduation with no knowledge of what awaits them as electrical engineers.

Those who answered the questionnaire were given the opportunity to add their own comments; they did, with a vengeance. These personal comments cannot be treated either summarily or statistically. They range far and wide in subject and opinion. They are often critical—of educational methods, of personnel practices in industry, of the status of engineering as a profession; yet, they show understanding of some of the things that lie at the root of that which they criticize. Three examples from many such comments are given to illustrate these.

> "While the greatest opportunities seem to be in the utility field, these companies seem the most reluctant to employ engineers. In spite of their admitted needs in the future, all the companies I talked with were cordial and considerate but were rather indifferent toward actual employment. Also, the salaries paid, while competitive in the long run, are not always competitive at present. While adequate, their starting rates are on the low side."

> "Try to stop the negative attitude of frustrated high school teachers that try to tell a student that he has no aptitude for engineering subjects. Many of the graduating engineers have experienced the same problems. Many good students are turned away from scientific and engineering studies in their early years. I don't think that a high school or grade school teacher is in a position to know the future potentialities of a student."

> "I still do not know enough about the details of many of the types of work and positions to be truly able to evaluate them. During my years in college I would like to have received some unbiased information on just what the engineers for various companies actually do—the raw, cold facts."

The comments show intelligence and tolerance. Some students state definitely their belief that many high schools and colleges have staffs that are below normal in quality, quantity, and rate of pay. Furthermore, frequent complaints of the respondents are that curricula should be revised, and that the students would be better equipped to select their future course of action if the colleges and employers gave better and more adequate information of the work and opportunities that would be available after graduation.

An important inference is this: the young graduates in electrical engineering are intelligent, able, ambitious, and adventuresome. Most of them do not seek special privilege, but they deserve from their predecessors an environment in the profession of engineering conducive to making their own contributions to its development.

SUMMARY

ONE OF THE PRINCIPAL PURPOSES of the survey was to obtain views and opinions of students regarding the different kinds of jobs offered to them and what influenced their selection of a job. It was hoped that the results of the survey would present some definite suggestions on how the various electrical engineering fields could be made more attractive to students and prospective students and thus help reduce the apparent shortage of engineers.

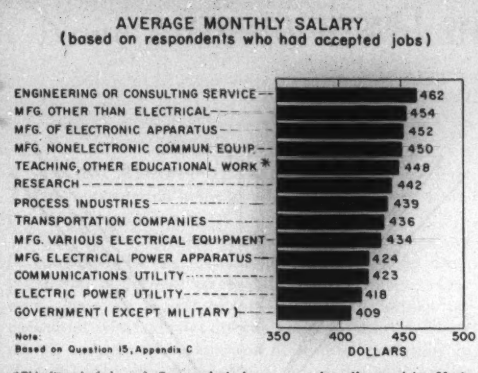
Some of the major results of the survey that have been presented in this paper may be summarized as follows:

The majority of the students desire to enter the more technical fields of research and development.

Work involving electronics was considered to be the most desirable (37% of positions accepted were in this field). Apparently the recruiting was more energetic and the salaries were higher.

Manufacturing of electrical equipment, manufacturing of nonelectrical equipment, and research were next most attractive and accounted for 13%, 9%, and 8%, respectively, of the positions.

The older fields of electrical engineering work such as



*This item includes only 7 respondents known as seniors; the remaining 21 students are M.S. or Ph.D. candidates or did not indicate the degree which they expected to receive.

Fig. 7.

electric utilities, communication, and transportation have little attraction for electrical engineering students today. None of these groups account for more than 6% of the accepted positions. In general, but with some very definite exceptions, the information presented to the students about such industries is inadequate; salaries are only average or below average, and recruiting may not be well organized.

Many of the students have little actual knowledge of the work that they may undertake after graduation. There should be more opportunities for summer work, co-operative work and study programs, or other means to broaden the education of the students and inform them of the work opportunities that exist in engineering.

Training programs are considered very important in selecting a job, and opportunities for graduate study are considered essential or desirable by a majority of the students.

Some students believe engineering is losing in professional prestige and in economic status. The salaries are considered inadequate when compared with wages of factory workers or plumbers. Furthermore, doubt is expressed that there is a real shortage of engineers, except for recent graduates, and therefore the long-rang opportunities for engineers are not too favorable. Some believe the so-called shortage of engineers would disappear if employment practices were changed by just a few industries.

The electrical engineering graduates, by and large, are intelligent, able, and ambitious to get into new fields of endeavor. They are sometimes poignantly idealistic in the best sense; for example, one student states briefly an important truth: "There should be more education in human relations and moral principles in this country."

However, some show a great desire for financial security, and even special privileges to provide for their needs, regardless of the services they can supply to their employer. Some state a requirement for jobs located in specific geographic areas.

Educational policies and curricula should be reorganized at many colleges to provide more fundamental or basic education rather than so much specialization.

High school and college staffs should be strengthened to create desire for students to enter and continue in engineering studies.

At a few colleges, the administrative divisions do not seem to be fully alert to the activities, or maybe inactivities, of their staff.

There is a belief that the interviewing and placement policies of the employers and colleges could be greatly improved to inform the students more adequately of the work that will be expected of them and thereby assist them in deciding on their future employment plans.

Perhaps it is in order to conclude in a lighter vein. One student, taking advantage of the request for individual comments, stated that he expected to be awarded his Ph.D. in June 1957, and that he would seek "a job to exercise my creative abilities in a leisurely manner at a high salary in a good location." *Et tu, Brute!!*

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Shooting the Stars

A fool-proof, "sidereal equatorial mount" control system for guiding missiles to any pinpoint on earth has been developed by Minneapolis-Honeywell engineers. System uses the stationary North Star as a reference point in guiding missiles to targets.

Transistorized Phase Discriminators

A. N. DESAUTELS
ASSOCIATE MEMBER AIEE

IN AERONAUTICAL CONTROL, where extensive application may be made of phase discriminators with d-c output, use of the transistor in discriminator circuits has definite advantages. The transistorized discriminator can meet minimum size and power requirements, provide amplification with excellent reliability, and perform well over a wide temperature range.

The circuit shown in Fig. 1 will produce half-wave differential d-c current in a 3-terminal or split load. Discriminator action is furnished by the diodes D_1 and D_2. Considering the n-p-n transistor shown, when the points A and B are becoming positive at the same time, T_1 will conduct and current will flow through D_1 and one half of the load L_1. During the negative half cycle, T_1 is cut off and no current will flow.

If the signal phase at A is reversed and points A and C are becoming positive simultaneously, T_1 again will conduct with current flowing through D_2 and the other half of the load L_2. Once again, on the negative half cycle no current will flow.

There are many instances where it is preferable to use full-wave rather than half-wave discrimination. The large fundamental ripple on the half-wave d-c output would necessitate use of shunting capacitors in hydraulic valve or relay drive applications. Full-wave discrimination would eliminate the need for any capacitor in most instances and can be obtained through the summing of two half-wave actions.

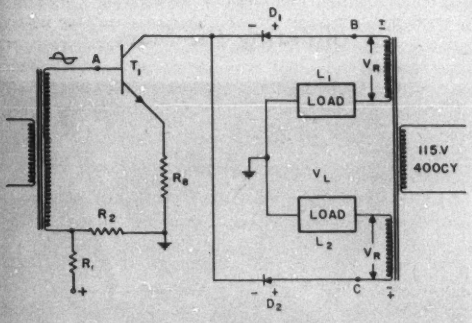

Fig. 1. Half-wave discriminator.

The full-wave unit is found to be a high-sensitivity temperature-stable device capable of utilization in a variety of control applications. Conversion of the full-wave discriminator with 3-terminal (or split) load to 2-terminal load results in a considerable loss of useful power through bleeder resistors, which dissipate five-sixths of the total power output. However, an adequate useful power output can be obtained with the 2-terminal load depending upon the maximum ratings of the transistors. The manner in which the transistor is operating in the full-wave circuitry permits power outputs many times the maximum effective power dissipated per transistor.

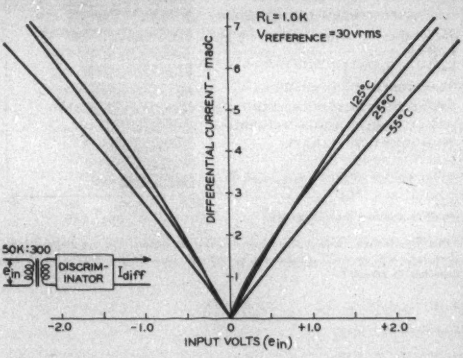

Fig. 2. Output current as a function of input voltage for the full-wave transistorized discriminator with 3-terminal output.

The response of the transistorized full-wave discriminator with 3-terminal output was observed under conditions of temperature extremes. The transistors used were randomly selected silicon junction types, and all diodes were silicon junctions. The phase-reversal signal source was coupled to the discriminator by a transformer which presents an impedance ratio of 50,000 ohms to 330 ohms on each side of the center-tapped secondary, or a voltage step-down ratio of about 12.

Fig. 2 shows the response for temperature extremes of 125 C and –55 C, as compared to 25 C. Note that considerable power gain is present in this circuit. At 25 C and 125 C, a power gain of better than 25 db is indicated, whereas at –55 C power gain is only slightly less than 25 db.

The transistor operates in the discriminator circuitry in a manner which enables it to handle load powers well in excess of maximum effective collector dissipation ratings. The primary power output limiting consideration appears to be the maximum current and voltage rating of the transistor insofar as these ratings contribute to the maximum collector dissipation rating.

Digest of paper 57-31, recommended by the AIEE Committee on Electronics and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Communication and Electronics*, 1957.

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Noise Problems in Motor-Driven Home Appliances

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DURING RECENT YEARS, the reduction of noise in motor-driven home appliances has become a major design consideration.

Many factors affecting product noise acceptance can be controlled by the manufacturer and, in some cases, prediction of relative acceptability can be made. However, there are several factors, other than human peculiarities, which are not directly under his control. These are (1) ambient or background noise level prevailing in the appliance area, (2) acoustical properties of the room in which the appliance is located, and (3) floor construction on which the appliance is mounted. The first of these is obviously important, both from a sales and a home location viewpoint.

The acoustical properties of the room in which the appliance is to be located are important, inasmuch as the sound pressure level at distant points of a room will depend upon its reverberant characteristics.

Vibration transferring from the appliance feet can be transmitted through joists and studding to other rooms where the resulting noise level may be a cause for dissatisfaction.

The electromagnetic forces associated with a single-phase induction motor can be broadly classified as (1) slot harmonic forces, (2) dissymmetry harmonic forces, and (3) torque and solenoidal pulsating forces.

With proper motor design, the inertia forces developed by the slot harmonic forces are cancelled out within the motor frame and thus transfer little vibration to the appliance with most mounting systems. Dissymmetries, however, often introduce unbalanced air-gap forces which can cause rotor and end-bell flexure. Mounting systems employing the through bolts can, if not properly designed, transfer much of this vibratory energy to the appliance.

Torque pulsations, occurring at a basic rate of twice line frequency are inherent in a single-phase motor, but can be considerably reduced in amplitude by the use of a permanent split-phase design. The torsional vibration of the motor acts in shear on the air, producing little or no sound. However, the vibration can be quite effectively coupled to the appliance and, hence, radiated as sound if proper vibration isolation is not provided. An axial component of this force exists with rotor skew and, if troublesome, can be reduced by use of a herringbone skew pattern.

Another axial force acting at twice line frequency exists due to the solenoidal action of the magnetic field. The magnitude of this force depends upon relative rotor to stator lengths and washered positions as well as the flux density. As in the case of the axial component of torque pulsation, vibration from this source can be effectively coupled to and radiated by the appliance.

Some method for reducing vibration transmission are (1) increasing motor mass, (2) adding a tuned vibration absorber to the motor or vibrating part, (3) using an inertia friction vibration damper on the motor, and (4) using vibration isolation between the motor and appliance.

Although each of these methods has unique advantages, the use of properly designed vibration isolation techniques is perhaps the most universally applicable. Basically, it consists of supporting the motor relative to the stator with springs so that the inertia forces of the vibrating motor and springs oppose the applied forces. Although this method is quite commonly applied, it is as often misused as not. Many cases have been observed where the elimination of the "isolation mounts" reduced important noise-producing vibration transfer. It should be kept in mind that the improper use of isolating materials may actually increase the transfer of vibrating energy as compared to a rigid mounting system. Provision of adequate isolation of all the motor forces from the appliance can be obtained by providing a spring constant in the motor mounting supports for each direction of vibration which will yield a resonant frequency sufficiently lower than the lowest vibration frequency.

The effectiveness of vibration mountings can be increased by attaching the mountings to nodal points or points on the motor with the least vibration, such as locations close to the shaft for the torsional mode. Mountings should be attached symmetrically about or in the plane of the motor center of gravity to keep the vibration degrees of freedom to a minimum and the mountings simple and low in cost.

In designing an appliance for minimum noise radiation, it should be borne in mind that besides plate and beam resonances, parts of the appliances, such as washer tubs, may form cavities which have resonances similar to a Helmholtz resonator. These resonances should be kept as far from force frequencies as is practicable.

The wide range and high amplitude of vibrations which can be transmitted from a motor to the appliance and the inherent sensitivity of many appliance parts to low magnitude vibrations result in a motor–appliance relationship which is highly complex. The best design of an isolation system is the one which integrates the pecularities of both motor and appliance design with realistic requirements for both so that a smooth transition from motor to appliance is evidenced.

Digest of paper 57-27, "Some Problems and Design Factors Concerning Noise in Motor-Driven Home Appliances," recommended by the AIEE Committee on Domestic and Commercial Applications and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Applications and Industry*, 1957.

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SEMICONDUCTORS

An Outline

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In this two-part article the properties of semiconductors are discussed, as well as the relations of these properties to formal solid-state and conduction theory and applications to such devices as transistors, rectifiers, and photocells. Some recent findings on the properties of silicon and germanium, and a discussion of some of the more modern techniques for making semiconductor devices are included.

FROM AN ELEMENTARY point of view, a semiconductor may be considered to be an electronic conductor which has a negative temperature coefficient of resistance over some temperature range. Although, like many definitions, this one does not cover all possible semiconductors, there are but few exceptions, such as, perhaps, degenerate semiconductors or "semimetals."

The negative resistance coefficient is illustrated in Fig. 1, which shows the temperature dependence of the resistance of a semiconductor, in this case germanium. Results from three samples are shown. The samples differ only in that they contain slightly different quantities of an impurity, such as arsenic.

The resistivity ρ (ohm-centimeters) is defined as RA/L, for the case of a rectangular block of length L and cross section A, R being the resistance in ohms to the flow of electric current. Several important properties of semiconductors are apparent from the diagram:

1. Semiconductor properties depend upon impurity content. Particularly in the low-temperature region, the resistance of the germanium samples is inversely proportional to the amount of antimony present. The resistivity of germanium may vary from 0.001 ohm-cm to the intrinsic value of about 50 ohm-cm at room temperature, depending upon the impurity content.

2. At higher temperatures, the resistivity is independent of the impurity content, and is a property of the material itself. This is the intrinsic range, ranging in temperature all the way down from the melting point to a temperature determined by the impurity content. As seen from the graphs, the higher the impurity content, the higher the temperature required before the intrinsic conduction becomes predominant.

3. In the intermediate range, the samples have a positive temperature coefficient, like most metals.

The aforementioned properties are to be accounted for in terms of the band theory of solids. The impurity atoms are capable of releasing electrons, with but very little energy required of thermal agitation. For germanium, for example, this would be the equivalent of the electron falling through a battery with a voltage of 0.01 volt, or 0.01 ev (electron volt). Once freed from the antimony the electrons can move freely through the lattice, according to laws derived from the formal theory of solid lattices, based upon the quantum theory of solids. The electrons can also be released from germanium atoms, but with more energy required, so that intrinsic conduction is not observed except at higher temperatures.

The intermediate range of positive temperature coefficient arises because all the electrons that can be released from antimony have done so, and the intrinsic conduction has not set in yet. Thus, the number of electrical carriers is constant, and the only source of temperature variation of resistance is in the mobility of carriers. The electrons are interfered with in their motion by the thermal agitation of the lattice, so that the resistance becomes larger at higher temperatures.

The equation expressing the resistivity in terms of mobility and carrier density is:

$$1/\rho = ne\mu \qquad (1)$$

where e is the electrical charge on the electron, 1.60×10^{-19} coulomb, μ the mobility in cm^2 per volt second.

Semiconductors and other solid crystals have the extremely important property of interacting with some of the electrons present in such a way as to make it appear that positively charged particles, rather than the usual negatively charged electrons, are present and carrying current. These positively charged particles, which are called positive holes, arise from the absence of an electron from a state of negative mass close to the top of a nearly filled band. Such particles are, in a sense, a mathematical fiction, inasmuch as they do not exist independently of a crystal. They do have unique properties, however. In particular, definite experimental techniques, including Hall effect and thermoelectric power, can be used to distinguish hole conduction from electron conduction. Hole-conducting semiconductors are called p-type and electron conductors n-type. The n-type semiconductors may arise from the presence of a donor impurity such as antimony in germanium, whereas p-type semiconductors may arise from the presence of an acceptor impurity, such as aluminum in germanium.

Part I of a two-part article, presented as a paper at the National Electronics Conference, Chicago, Ill., Oct. 1-3, 1956, and recommended for publication by the AIEE Committee on Solid-State Devices. The material in this article is included in a book "An Introduction to Semiconductors," by W. C. Dunlap, Jr., published by John Wiley & Sons, New York, N. Y., 1957.

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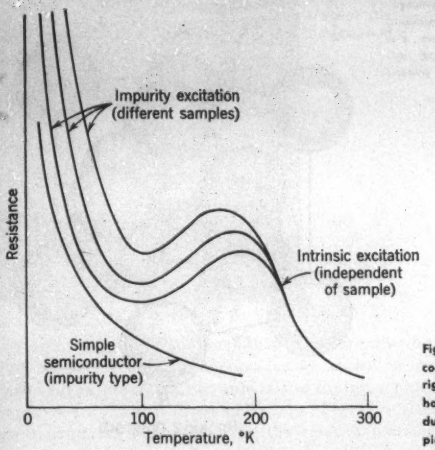


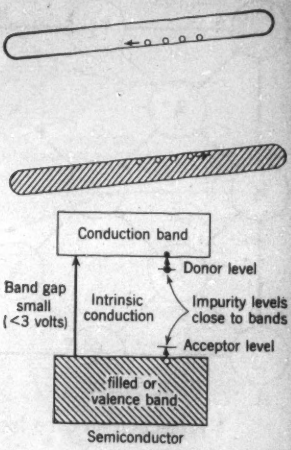


Fig. 1 (left). Negative temperature coefficient of resistance. Fig. 2 (top right). Analog for conduction by holes and electrons in semiconductor. Fig. 3 (bottom right). Band picture of bulk semiconductor.

Electrons and holes, of course, flow in opposite directions when an electric field is applied. The diagram of Fig. 2 illustrates a simple analogy, in which droplets of liquid resemble electrons, bubbles resemble holes. Tilting of the containers is analogous to application of a field.

The band picture (Fig. 3) of the donor and acceptor impurities, and of intrinsic conduction shows the localized impurity levels, the donor states often being close to the upper, or conduction, band and the acceptor states being close to the lower, or filled (valence), band.

CRYSTALS, IMPERFECT AND PERFECT

ALMOST ALL SEMICONDUCTORS are crystalline in nature, and the electrical properties of semiconductors, as other solids, are closely tied up with the regularity of structure possessed by crystals.

The atomic arrangement of a typical semiconductor is shown in Fig. 4. The atomic pattern of germanium is shown, including its unit cell, in this case a cube (called the diamond cubic structure, since it is also possessed by diamond and silicon). It is characteristic of crystal lattices that planes lying at various orientations are of importance in discussion of properties, and for this purpose the Miller indices are of importance. To give only particular examples, rather than a complete definition, Fig. 5 shows various planes of a cubic crystal and the designation of these planes in the Miller index notation.

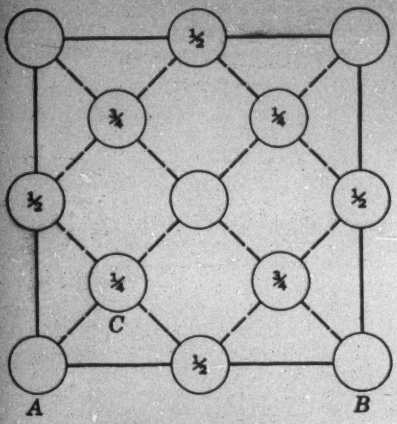
The planes of the crystal have the property of reflecting or diffracting electromagnetic radiations, making it possible to obtain X-ray diffraction photograph such as that of Fig. 6 for a germanium single crystal. The possibility of diffracting the waves associated with electrons gives rise to the characteristic band structure of metals and semiconductors. This structure is found theoretically by solving the Schrodinger equation of quantum mechanics, after it is formulated in a way suitable for crystals. Fig. 7 shows the bands formed for atoms spaced at various distances, including the discrete states characteristic of isolated atoms. The band picture of Fig. 3 is obtained by considering only the uppermost filled band and the first unfilled band of Fig. 7 at the actual lattice spacing.

Solution of the Schrodinger equation shows that the electrons in the conduction band have wave properties very similar to those of electrons in free space. The main difference is a multiplying factor that makes the electrons appear to have more (but in some cases, less) inertia than that of a free electron. Thus, the electrons (and holes) must be described by an effective mass (m^*). Many of the simple relations for free electrons also apply for electrons in crystals provided this effective mass is substituted for the free electron mass.

However, this concept of a single effective mass is only a rough approximation, suitable for simple crystals (the so-called spherical energy surface model) and, even then, only for the edges of the conduction bands. For more complex substances, including silicon and germanium, the properties require the use of several effective masses and, indeed, a different effective mass is required for almost every different property of the carriers. An important phase of present semiconductor research is the working out of the details of the band structure of silicon and germanium.

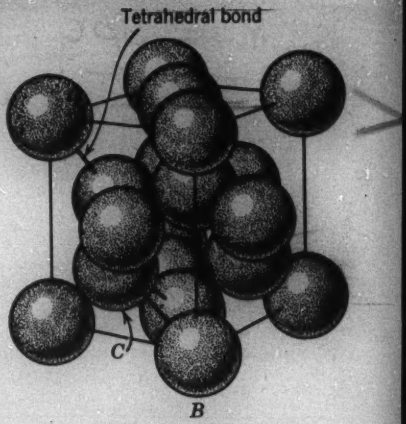
Real crystals are characterized almost as much by the imperfections present in them as by the structure itself. Imperfections may be of many kinds. Important among these are lattice vacancies (Schottky defects), interstitial atoms wedged between the normal lattice sites, foreign or impurity atoms, and thermal vibrations (phonons). Even the carriers themselves are discontinuities which distort the crystal and which, therefore, must be considered lattice imperfections.

Also important for many crystal properties are larger-scale imperfections, such as the dislocation and the grain boundary. The dislocation in its simplest form may be thought of as an extra half plane in the crystal, as shown



Projection on cube face

Fig. 4. Atomic arrangement of germanium. (Fractions indicate displacement of atom normal to plane of paper.)



Packing diagram

in Fig. 8. Another important variety of dislocation is the spiral dislocation, which is important in growth of crystals. Both edge dislocations and spiral dislocations may have electrical consequences for crystal properties, as well as being important in determining properties and growth.

For example, dislocations tend to scatter carriers and, therefore, may lower the mobility. They may also act as centers of recombination for carriers present in excess of the equilibrium density, as in the case in transistors and other p-n junction devices. They may also act as sources for electrical carriers, probably as acceptors, at least in germanium and silicon. The use of semiconductors to study the properties of dislocations and other imperfections is an important phase of today's solid-state research.

Returning to the impurity atom, a model which describes the impurity center discussed in the introduction is shown in Fig. 9. There one sees that the carrier, in this case the electron, swings about the impurity ion in an elliptical orbit very much like that of a hydrogen atom. The theory states that the behavior is very similar to that of an electron about a free hydrogen atom, but corrected for the screening effect described by the dielectric constant, and for the effective mass of the electrons. The ionization energy required to remove the electron is given by the Balmer formula for hydrogen, modified in this way:

$$E = \frac{13.56}{\kappa^2} \frac{m^*}{m} \qquad (2)$$

Using the value for m^* in germanium of $0.2m$ indicated by other results, and using the dielectric constant of germanium of 16, the ionization energy comes out about 0.01 ev, in good agreement with experimental results based upon the variation of resistivity with temperature.

More refined theories, based upon the Wannier method of calculation of impurity wave functions, account in somewhat more rigorous fashion for the value of the ionization energy. No results have yet been calculated, however, for the action of some of the elements that, unlike antimony and gallium, for example, produce deep, unhydrogenlike states in garmanium and silicon. These problems are among those in which important advances are to be expected during the next several years.

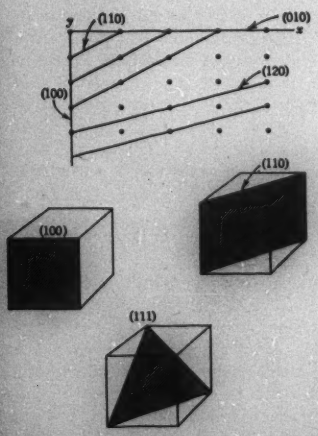


Fig. 5. Planes in a crystal, with Miller indices.

CONDUCTION PROPERTIES OF SEMICONDUCTORS

THERE ARE TWO ASPECTS of the theory of the conduction properties:

1. Calculation of the density of conducting carriers in terms of the impurity density, temperature, magnetic field, light intensity or other factors. This is a problem in statistical mechanics. The most useful generalization from the statistical mechanical results for electrons is that

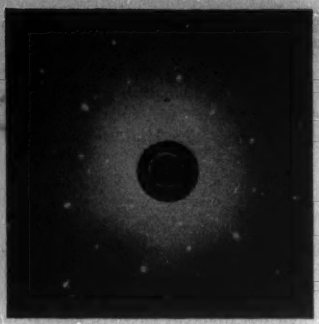


Fig. 6 (left). Typical X-ray diffraction photograph.

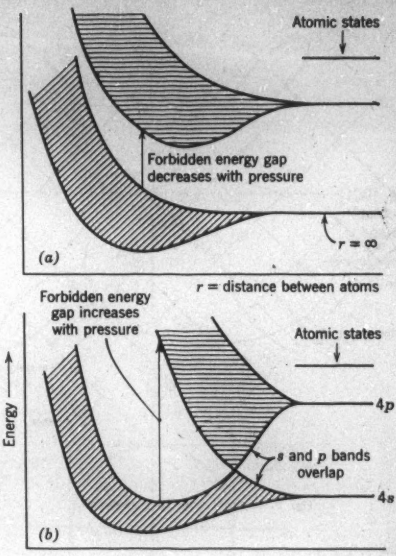


Fig. 7 (right). Band calculations for a semiconductor.

the electrons (or holes) in a semiconductor are distributed over the valence and conduction bands, according to the Fermi distribution. An example of the application of the Fermi distribution is given in Fig. 10. There we see the bands, and the function giving the relative number of electrons these bands are capable of holding at each energy. Also shown is the "density of states" function for the impurity. The Fermi function f has the form:

$$f = \frac{1}{e^{\epsilon - \epsilon_f/kT} + 1} \tag{3}$$

and is spread out along the vertical axis in such a way that the Fermi level, which is the value of the energy when the Fermi function has the value $1/2$, has the proper value to account properly for the number of electrons. Thus, the Fermi level is related to the constancy of the total number of carriers, regardless of the way the carriers are distributed over the energy bands, for electrical neutrality to be preserved.

Application of the methods in a more mathematical way leads to a relation for Fermi level in the case of a single impurity level:

$$\epsilon_f = -\frac{\epsilon_d}{2} + kT \ln \left(\frac{2\pi m^* kT}{h^2}\right)^{\frac{3}{4}} N_d^{\frac{1}{2}} \tag{4}$$

where ϵ_d is the energy level and N_d the density of the impurities. This equation holds only for the region of relatively low temperatures, when the fraction of impurity centers ionized is small.

The density of carriers can be determined from the Fermi level by the equation, for the simple spherical energy surface model:

$$\text{Electrons: } n = \left(\frac{2\pi m^* kT}{h^2}\right)^{\frac{3}{2}} e^{\epsilon_f/kT} \tag{5a}$$

$$\text{Holes: } p = \left(\frac{2\pi m^* kT}{h^2}\right)^{\frac{3}{2}} e^{(\epsilon_g - \epsilon_f)/kT} \tag{5b}$$

where ϵ_g is the value of the band gap.

The product np is found to be a constant depending only upon the temperature and the band gap, but independent of the actual impurity content or resistivity. This is akin to the "mass action law" of chemistry and is important in the theory of transistors and rectifiers as well as of the bulk properties. Thus

$$np = \left(\frac{2\pi m^* kT}{h^2}\right)^3 e^{-\epsilon_g/kT} \tag{6}$$

2. Once the density of carriers is known, the conduction theory involves mainly the evaluation of the various important properties of the conductor, such as the Hall coefficient and the thermoelectric power, in terms of this carrier density. Also, a very important aspect of the theory is the evaluation in terms of fundamental lattice properties of the mobility defined in equation 1. Fig. 11

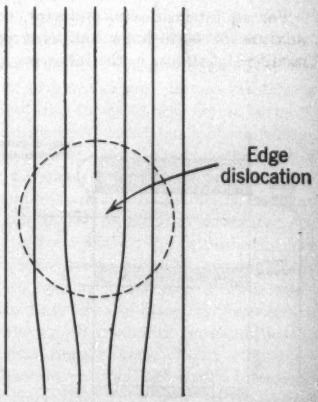


Fig. 8. Dislocation.

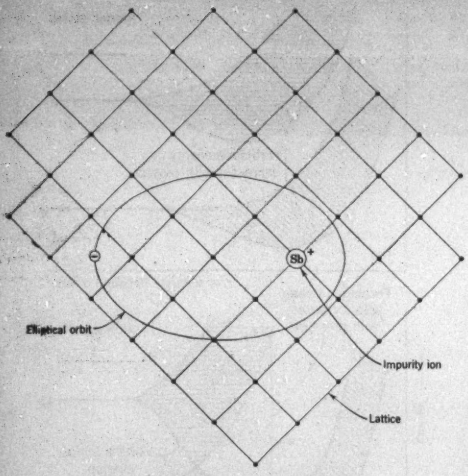


Fig. 9. Impurity orbit in germanium.

shows an arrangement for the measurement of the Hall coefficient. This effect depends upon the action of a magnetic field upon the current, and the tendency of the carriers to be deflected to one side of the sample, where they build up an electrostatic field compensating for the magnetic forces. The Hall coefficient for a simple one-carrier semiconductor is defined as

$$R = Vt/IH \ (\times 10^8) \tag{7}$$

in electromagnetic units (emu). In cm³/coulomb units, the factor is 10^8.

In terms of the carrier density for a simple one-carrier semiconductor the absolute value of the Hall coefficient (neglecting effect of sign of carrier) is

$$|R| = \frac{(3\pi/8)}{ne} \text{ emu} \tag{8}$$

For an intrinsic semiconductor, or one containing a mixture of both holes and electrons, the relation is modified, as shown in the following equation:

$$|R| = \left(\frac{3\pi}{8}\right)\frac{1}{e}\frac{(n\mu_n^2 - p\mu_p^2)}{(n\mu_n + p\mu_p)^2} \tag{9}$$

Another situation of considerable interest in the complex valence band structure of germanium, where there appear to be two types of holes—"fast" and "slow"—each having its own effective mass. The Hall effect for this case is given by

$$|R| = \frac{3\pi}{8e}\frac{[1 + (n_2/n_1)(\mu_2/\mu_1)^2]}{[1 + (n_2/n_1)(\mu_2/\mu_1)]^2} \tag{10}$$

Where n_1 and n_2 are the densities of the two types of carrier, and μ_1 and μ_2 are the corresponding mobilities.

Another case of two-carrier conduction where the carriers are both one sign but different effective mass is in impurity band conduction, where the extra carriers are, say, electrons of high effective mass that can move directly from impurity atom to impurity atom. In this case also a formula such as that of equation 10 applies, modified somewhat because of the effect of impurity scattering at the high impurity contents involved. The nature and properties of the complex band structure for silicon and germanium will be discussed more fully.

Another important conduction property is the magnetoresistance, namely, the increase in resistance due to the application of a magnetic field. The simple theory predicts that the magnitude of the change is given by $\Delta\rho/\rho_o = BH^2$, where the constant $B = 0.38\ \mu^2 \times 10^{-10}$. Again it is found that this theory is valid for simple semiconductors having spherical energy surfaces, but not for germanium and silicon. These semiconductors are, in particular, characterized by large magnetoresistances when the current and magnetic field are in line (longitudinal effect). For simple semiconductors, however, the effect in this case is zero. Analysis of the magnetoresistive directional effects has been an important study for the establishment of the correct shapes of the energy surfaces for silicon and germanium.

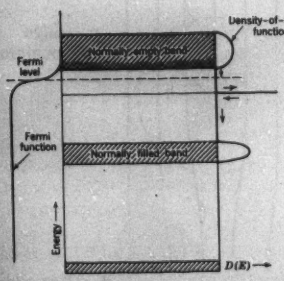


Fig. 10 (left). Fermi distribution function for a semiconductor.

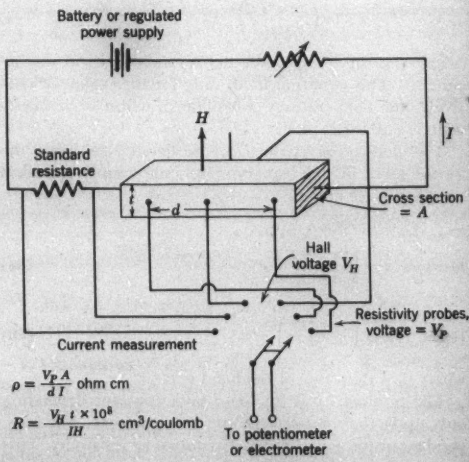


Fig. 11 (right). Hall coefficient measurement system.

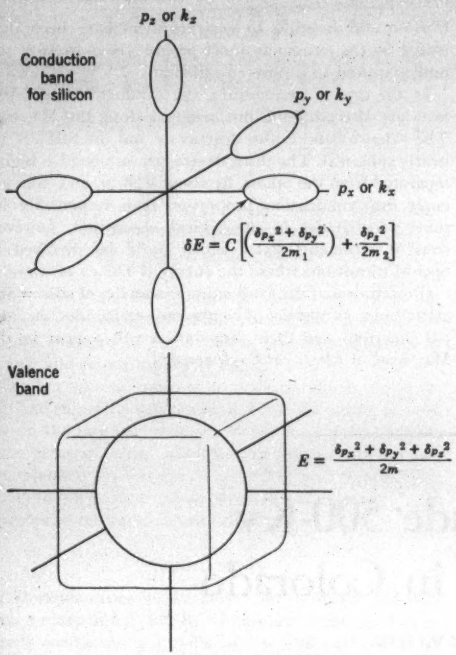

p_z or k_z
Conduction band for silicon
p_y or k_y
p_x or k_x
$\delta E = C\left[\left(\frac{\delta p_x^2 + \delta p_y^2}{2m_1}\right) + \frac{\delta p_z^2}{2m_2}\right]$
Valence band
$E = \frac{\delta p_x^2 + \delta p_y^2 + \delta p_z^2}{2m}$

Fig. 12. Energy bands in silicon.

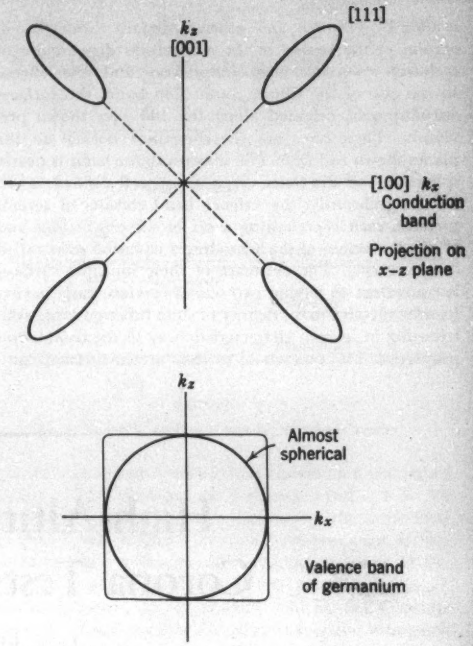


Fig. 13. Energy bands in germanium.

Another effect of considerable importance is the thermoelectric or Seebeck effect, which is the generation of the electromotive force obtained when a semiconductor bar is heated to two different temperatures at the two ends. Metallic leads soldered to the bar then have a difference of potential which turns out to be, in most cases, independent of the metal used and dependent only upon the semiconductor.

Recent conduction studies have also brought about new effects not previously found in semiconductors. Among these are the resonance effects; specifically, (1) cyclotron resonance, and (2) donor spin resonance.

Cyclotron resonance is obtained by applying a magnetic field and a high-frequency electric field (about 3,000 mc) to a semiconductor sample, usually held at a low temperature. The conditions must be adjusted so that the electron orbits are of the order of a mean free path or smaller, when absorption can be observed. If the temperature is too high, the resonance is broadened, and little resonance absorption can be observed. By studying the resonance absorption due to electrons in circular orbits, much useful information about energy bands in germanium, silicon, and indium antimonide has been obtained.

In the second case, that of donor spin resonance, the resonance absorption in silicon containing a rather high impurity concentration is observed. The effect here depends upon the orbital motion about the donor ion, and the tendency of the spin vector of the bound electron to precess about an external magnetic field at the so-called Larmor frequency. Again, the effect leads to increased absorption of r-f energy in a wave guide, and information about the interaction between the electron and the lattice can thus be obtained.

PROPERTIES OF MONATOMIC SEMICONDUCTORS

Silicon and Germanium. As indicated previously, the effect of the crystal structure upon electron motion is partially described by the forms of the Fermi surfaces. These describe the directional dependence of the energy as a function of velocity. For a simple two-band model of the semiconductor, the surfaces are spherical for both the conduction band and the valence band. Many semiconductors have a much more complicated structure. For these more complicated models, all the formulas for the conduction properties have to be modified, although only the numerical factors have to be modified in some cases. The more complicated models also bring in effects which do not occur with the simple model as, for example, the longitudinal magnetoresistance effect.

Figs. 12 and 13 show the energy band models for silicon and germanium as determined partially from theoretical

studies by Herman and others, partially from consideration of the results of the orientation dependence of cyclotron resonance, magnetoresistance, and other effects. In the case of the silicon conduction band, the surfaces are ellipsoids, oriented along the 100 axes shown previously. These axes are the directions normal to the planes shown in Fig. 5. The silicon valence band is nearly spherical, and the exact shape is not well defined as yet. More significantly, the valence band consists of several surfaces, each representing a set of wave functions and allowed solutions of the Schrodinger equation (case called "degeneracy"). The existence of these multiple surfaces is equivalent to having two sets of carriers, each having its own effective mass, density of state functions, and contributing in its own characteristic way to the conduction properties. The two sets of carriers are in thermal equilibrium and attempts to separate them have been frustrated by the extremely short period (10^{-12} to 10^{-13} second) required to restore equilibrium.

In the case of germanium, the conduction band surfaces are also ellipsoid, but oriented along the 111 axes. The valence band is also degenerate and the surfaces are nearly spherical. The third degenerate sub-band is highly separated from the others, by about 0.28 ev, and does not enter into conduction properties. It is responsible for some peculiarities in the optical absorption, however, since it represents states which could be involved in optical transitions where the energy is 0.28 ev or more.

(Description of the conducting properties of silicon and germanium, properties of compound semiconductors, and p-n junctions and their preparation will appear in the May issue of *Electrical Engineering*.)

High-Altitude 500-Kv Corona Tests in Colorado

L. M. ROBERTSON
FELLOW AIEE

Growth and proposed developments in the Colorado Rocky Mountain area will overload the present system in the near future, necessitating expansion of present facilities and use of higher transmission voltages. An extensive program for the evaluation of corona, radio influence, and mechanical design under high-voltage and high-altitude conditions is described.

THE PLANS for transmission development by the Public Service Company of Colorado indicate the need of a transmission voltage higher than the present top level of 115 kv. In the Rocky Mountain area, west of Denver, Colo., system growth and proposed developments will overload the present system in the not-too-distant future. The altitude of the existing 115-kv circuits west of Denver and such new circuits as may be needed is the highest of any lines in the United States. It is expected that future lines here will have an average altitude of approximately 10,000 feet and will be required to cross the Continental Divide through 12,000- and 13,000-foot passes. Obviously, construction in this mountainous area is difficult and mechanical loading during storm conditions severe. For these reasons, it is important to design for the simplest tower configurations and for minimum conductor sizes compatible with good corona and radio influence performance.

The use of more than one conductor per phase (bundled conductors) may be an effective means of minimizing the conductor size. The low barometric pressure combined with the difficulties of handling large conductors in the mountainous terrains makes this approach appear desirable. However, this type of construction has not been used at high altitudes, or in weather conditions as severe as those found in the Rocky Mountain passes. In addition, there appears to be presently available no reliable data from which the corona and radio influence performance of lines at high altitudes may be estimated.

Thus faced with the problem of designing high- or extra-high-voltage lines for high-altitude service, it has become apparent that a preliminary field test program is a prerequisite for such design. For this reason, the Public Service Company of Colorado has entered into a joint program with several manufacturers to evaluate corona, radio influence, and mechanical line design at high altitudes.

The 6,700-foot long test line has been erected near Leadville, Colo., adjacent to an existing 115-kv to 12-kv stepdown substation. The test site is located on a high plateau between two mountain ranges at an altitude of 10,500 feet. There are seven peaks within a radius of 17 miles of the site that have altitudes of greater than 14,000 feet. The terrain adjacent to the substation permitted taking several spans over relatively level land and a final span over Iowa Gulch of sufficient length to provide what

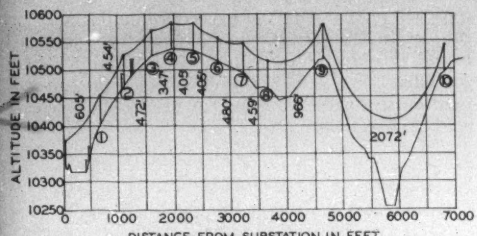


Fig. 1. Profile of Leadville test line.

should prove to be interesting data concerning the mechanical performance of the conductors. A profile of the line is shown in Fig. 1, and a schematic diagram of test line and power supply in Fig. 2.

Weather records indicate that severe winter temperatures and snowfalls will render difficult the taking of field data on the line performance. In order to overcome this to the greatest extent possible, the instrumentation has been planned for automatic recording and transmission of data to the existing substation building, wherein it will be recorded on multichannel charts.

CONDUCTORS

THE CONDUCTORS TO BE TESTED are a single 1.65-inch diameter expanded ACSR (aluminum cable, steel reinforced) conductor, a bundle of two 0.92-inch diameter ACSR conductors spaced 16 inches between centers, and a bundle of two 1.40-inch diameter expanded ACSR conductors also spaced 16 inches apart. The first 2-bundle conductors were chosen to be identical with ones tested at the Tidd test site to give a direct comparison at a different altitude. The larger bundle was chosen on the basis of the limited information available as being somewhat larger than would be estimated to be necessary for 345-kv operation at these altitudes.

The bundle of two 1.40-inch diameter conductors has been strung with four conductors spaced 16 inches horizontally and vertically for initial operation, for the calibration of meters and study of the 4-bundle arrangement. The two lower conductors will be removed later.

The two overhead ground wires are 159,000 CM (circular mil) ACSR 12/7.

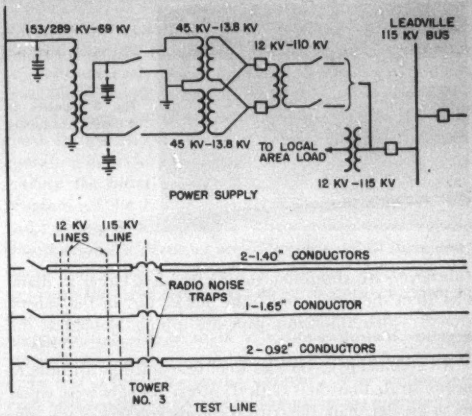


Fig. 2. Schematic diagram of test line and power supply.

Conductor sags and tensions were based on a maximum loading of ½-inch radial ice, 8 pounds wind at 0 F. All line conductors will have approximately the same final sag at 60 F, which is 63.5 feet in a 1,400-foot span. Under the foregoing conditions, the maximum tension in the 1.65-inch conductor will be 14,000 pounds; in the 2-bundle 0.92-inch, 15,520 pounds; and in the 2-bundle 1.40-inch, 23,660 pounds. In no case does the maximum tension exceed 50% of the ultimate strength of any of the conductors.

It was assumed that the 4-bundle conductor would be reduced to 2-bundle before any heavy ice loading would be present. However, the tension at 0 F with no ice and no wind on the 4-bundle as installed would be 24,400 pounds. The maximum tension in the overhead ground wire will be 6,600 pounds, or 43.5% of ultimate strength.

Tapered armor rods are used at each suspension point. Single stockbridge dampers for each conductor are provided at the end of each span except in the case of the 2,072-foot span. Here two dampers are used at each end of the span on each conductor. No armor rods are used on the ground wires, but dampers are employed as in the case of the conductors.

Compression dead ends and joints are used with corona shields placed at the ends of the joints. The compression dead ends are adequately shielded by the insulator shield rings. The dead-end bodies and aluminum joints are the latest tubular design, wherein the cross section is hexagonal after compression.

The spacers are of two types. The first is an articulated design (Fig. 3) consisting of two aluminum conductor clamps connected to a tubular aluminum spacer member with restraining springs maintaining high-pressure contact surfaces in the linkage. The second type employs the same kind of conductor clamps which are rigidly attached to a flexible spacer member consisting of a closed helical stainless-steel spring (Fig. 4). Spacers are arbitrarily installed about every 200 feet in each span.

All conductor jumpers at dead-end structure 3 and the

A condensation of paper 57-161, "Public Service Company of Colorado 500-Kv High-Altitude Corona Tests," consisting of a group of three papers recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. The following papers are included in this group:

1. Colorado High-Altitude Corona Tests—Scope, Tests, and Instrumentation. *L. M. Robertson*, Public Service Company of Colorado, Denver, Colo.; *C. F. Wagner, T. J. Bliss*, Westinghouse Electric Corporation, East Pittsburgh, Pa.

2. Colorado High-Altitude Corona Tests—Insulators and Associated Hardware. *L. M. Robertson; A. D. Lantz, Jr.*, The Ohio Brass Company, Barberton, Ohio.

3. Colorado High-Altitude Corona Tests—Conductors, Towers, and Footings. *L. M. Robertson; P. T. Coffin*, Aluminum Company of America, Pittsburgh, Pa.; *H. M. Walton*, American Bridge Division, U. S. Steel Corporation, Pittsburgh, Pa.; *R. G. Yerk*, Hughes Brothers, Inc., Seward, Nebr.; *O. H. Huggins, N. E. Desenberg*, Malleable Iron Fittings Company, Branford, Conn.

Fig. 3. Spacers on 4-bundle conductors.

substation are aluminum tubing which is larger in diameter than the conductors. The 500-kv bus in the substation is 3-inch aluminum pipe-size tubing, welded at the joints.

All conductor accessories were tested at low altitude to demonstrate that their critical corona voltages were equal to, or greater than, the critical corona voltages of the conductors with which they are associated.

A basic desire in planning the test line was to duplicate as nearly as possible the conditions on a regular operating transmission line. A minimum of corrections would then be required to apply test data to the design of a new line. However the strict application of such a philosophy becomes extremely expensive in terms of both time and money, and makes necessary some compromise. For example, to test more than one conductor size in 3-phase operation requires either the construction of several test lines or a test program on a single line which is reconductored periodically. In the latter case, difficulty may well be expected in obtaining data under identical weather conditions on each conductor and the duration of the test program is greatly lengthened. Therefore, in planning the Leadville tests it was decided to use only single-phase voltage. In this manner, three different conductors on towers of practical 3-phase single-circuit design could be investigated concurrently.

As indicated in the profile of Fig. 1 and the schematic diagram of Fig. 2, the only practical route for the test line involved crossing both a 12-kv and a 115-kv circuit near tower 2 as well as several 12-kv circuits in the first span. Because of the possibility of radio-influence coupling between these circuits and the test circuit, radio noise traps are installed in the test line at tower 3. These traps will prevent radio noise generated on the other circuits or in the test substation from being propagated beyond this tower. Measurement of r.i. (radio influence) generated by the test conductors can then be made beyond tower 3 with assurance that undesired signals are not being received.

Fig. 4. Spacer on 2-bundle conductors.

TEST SUBSTATION

THE HIGH-VOLTAGE SUBSTATION is shown in Fig. 5.

Disconnect Switches. The use of three different conductors on the test line makes impossible the simultaneous recording of the r.i. generated by each conductor. This is the case since with all conductors energized there is no way to segregate the r.i. created by one conductor from that created by the others. To obtain measurements on the three test conductors under essentially the same weather conditions, it then becomes necessary to provide means of switching quickly from one conductor to another. For this purpose, three 330-kv single-pole motor-operated disconnect switches are provided at the sending end of the line.

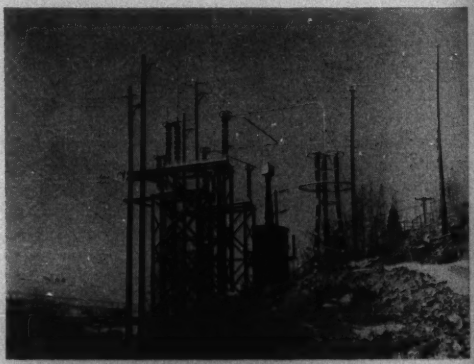


Fig. 5. Leadville substation with 500-kv transformer, lightning arrester, 330-kv motor-operated switches, supporting structures, and cross ground wires to ground switch blades when open.

Transformer. The transformer used to supply the test line is rated 1,667 kva and rated 69 kv on its low-voltage winding. The transformer has 25 tap combinations permitting the high voltage to ground to be varied from 153 to 289 kv.

Power Supply. Because 69 kv is not available at the Leadville substation and two 1,500-kva 13.8-kv to 45-kv transformers are available there, the 69-kv winding of the test transformer is energized either at 45 kv with one terminal grounded or at 90 kv with a grounded midpoint. In the latter connection, the full range of low-voltage taps on the test transformer is not used, in order to avoid raising the volts-per-turn above the design value.

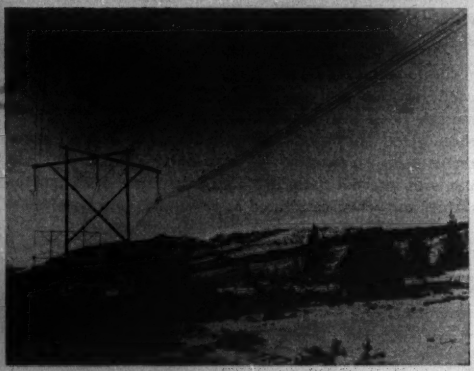


Fig. 6. Wood pole H frame no. 4, modified spar design with fiberglas enclosures for radio influence meters in foreground.

The circuitry on the low-voltage side of the test transformer is shown in Fig. 2. By using the alternate power supply connection it is possible to vary the test line voltage in 34 steps from about 100 to 300 kv above ground.

Lightning Arresters. The high-voltage winding of the test transformer and the high-voltage substation insulation are protected by a 350-kv self-supporting "Auto-Valve" lightning arrester. In addition, one 50-kv arrester is applied at each terminal of the test transformer 69-kv winding.

CONVERSION OF SINGLE-PHASE DATA

ALTHOUGH measurements of both corona loss and r.i. will be undertaken on only a single-phase basis at Leadville, the data will be of little practical value if they cannot be converted in some manner to become applicable for practical 3-phase line designs.

Concerning corona loss data, there is no doubt that satisfactory conversion can be made, based upon the concept of maintaining constant nominal gradient in the conversion.

The conversion of r.i. data is rendered more difficult by the fact that the field pattern of radiated radio-frequency (r-f) noise signals is not the same in the case of the test line with but one of three conductors energized as in the case of a practical operating line with all phases energized. However, it is expected that the data taken at Tidd and elsewhere in both manners will provide means for making satisfactory conversions of the Leadville r.i. data.

TEST PROCEDURE

DURING THE INITIAL STAGES of energization, particular care will be taken to obtain both r.i. and corona data which will reflect the initial surface condition of the conductors. With but one conductor energized at a time, readings of the radiated r.i. field will be taken both laterally and longitudinally with respect to the conductor at various voltages. Weather conditions permitting, it is planned that fair weather corona loss measurements will be made on each conductor over the range of voltage available at weekly intervals. During the period between these voltages "runs" all three conductors will be energized, in order to accumulate the maximum number of operating hours as promptly as possible.

Once the initial energization period is over, the test program will be directed toward the accumulation of loss and r.i. data as a function of the weather. Inasmuch as simultaneous r.i. readings are impossible on all three conductors, an automatic switching sequence will be set up to obtain the most useful data on each conductor with as nearly continuous energization as possible. Accordingly, long-time tests will be made at various constant voltages wherein the motor-operated disconnect switches will carry out a preset switching sequence. The sequencing cycle will repeat hourly and will result in the energization of each conductor by itself for 5 minutes, its de-energization for 10 minutes, and the simultaneous energization of all conductors for 45 minutes.

INSTRUMENTATION

THE INSTRUMENTATION for the Leadville tests has been patterned after the Tidd test project instrumentation. Using the experience gained during those tests it is hoped that calibration of the instruments, gathering of data, and interpretation of the results will be less time consuming.

Due to the isolated location of the test line, much more dependence will be placed on graphical records than has been the practice in most previous tests. To insure correct time sequencing of the data, and to relieve the need to maintain chart drives at many locations, all information will be recorded on two synchronized multichannel recorders. These recorders, their associated amplifiers, and the line control are housed in the heated substation control room, where the normal substation operating crew is on continuous duty.

Fig. 7. Structure no. 3 and 330-kv coupling capacitor for connecting to conductors.

Fig. 8. Conventional single-circuit corset type lattice steel tower.

Weather Data. Recorded weather data will include rate of precipitation, barometric pressure, dew-point, temperature, and wind speed and direction. An automatically timed movie camera will also be used for indications of slight precipitation, snowfall, fog, and haze. Standard instruments have been used when available, but the need for central recording with a common multichannel recorder made it necessary to design either parts or complete units to convert some of the instrument output signals to operate into the recorder.

Sixty-Cycle Data. The 60-cycle data to be recorded include the voltage, current, and corona loss of the test conductors and also indications of which conductor is under test and the wattmeter scale in use. The voltage will be read from a metering winding in the high-voltage transformer. Current will be recorded from a current shunt in the neutral of the high-voltage winding. There will also be a nonrecording voltmeter and ammeter in the meter housing at top of the transformer high-voltage bushing for checking the accuracy of instruments at low voltage. These will be read visually during calibration and periodically to insure accurate test results.

The wattmeter used is a null-balance d-c indicating device designed for accurate reading at extremely low power factors.

To calibrate the wattmeter accurately, it is necessary to have a heavy capacitive load with known losses. A conductor is the best calibrating load in the range of voltages below the corona starting voltage within which the losses are essentially zero. To permit calibrating the wattmeter at Leadville in this fashion through all tap combinations of the test transformer, it was deemed worthwhile to provide a conductor whose corona threshold voltage is above the maximum test voltage. For this reason, the 2-conductor 1.4-inch-diameter bundle conductor has been initially strung as a 4-conductor bundle in a square configuration with 16-inch spacing on each side. It is expected that the maximum surface gradient on this bundle at the maximum test voltage will not result in corona, although checks will be made with the r.i. instruments to insure this.

Radio Influence Data. The radio influence meters to be used for this test are Stoddard *NM-20-B* radio noise meters. These instruments cover the range from 0.15 to 25 megacycles. They are suitable for both long-time measurements using an external 115-volt source and for portable use with internal batteries. This instrument is extremely stable, and when calibrated at reasonable intervals gives dependable results. All radio frequency measurements are being made beyond tower 3, where the radio noise traps are located.

Fig. 9. Tubular steel H frame.

Small buildings designed to protect the instruments from weather conditions and also allow r-f transmission with a minimum of attenuation are shown in Fig. 6. These buildings are built of corrugated fiberglas sheets and are designed so that heavy snow will not influence the meter readings. Inside each building a meter will be installed in a wooden chamber where thermostats control a fan and heater to maintain a fairly constant temperature. In this manner, any effect of ambient temperature on the meter calibration will be eliminated. Power for the instruments, heaters, and fans is brought to the instrument housing by buried 115-volt circuits from a distribution transformer on the nearest 12-kv circuit.

The r.i. meter output signals are transmitted over three buried r-f transmission cables to the substation control house where they are recorded with the other quantities.

The r.i. metering equipment described is, of course, for the purpose of measuring the radiated r.i. signal strength. In addition, provisions are being made to measure the generated r.i. signal directly on the conductors by means of the standard NEMA (National Electrical Manufacturers Association) circuit. To accomplish this, a coupling

capacitor has been mounted on a low-bed trailer so that it may be hauled from beneath one conductor to another or along the line (Fig. 7). Connection between the capacitor and conductor will be made by means of temporary tubular aluminum connectors. To permit recording of the data it is expected to use this setup between towers 3 and 4 and make use of one of the three twisted-pair coaxial r-f cables for transmission of the signal to the recording equipment in the substation control house.

STRUCTURES

Steel Tower. Installation no. 9 is a conventional single-circuit corset type lattice steel tower, as shown in Fig. 8. This tower is one of the few 330-kv single-circuit structures of this type built in the country and, therefore, economic considerations were paramount in the selection of its configuration. The height of the structure of 82 feet and the electrical clearances of 31-foot phase spacing were kept to a minimum consistent with good engineering practices.

Fig. 10. Wood pole H frames and steel tower, showing stringing of 4-bundle phase conductors.

The tower is designed to support the three cables and two ground wires over average spans of 1,150 feet and through an angle of 5 degrees or on a maximum tangent span of 1,700 feet. This tower is the only suspension structure in the test line designed to sustain a major longitudinal emergency loading resulting from a broken conductor or ground wire. Design tensions and transverse loadings are based on 8-pound wind on ½-inch ice-covered cables and a transverse wind loading of 13 pounds per square foot or one and one-half times the projected area of one face of the tower.

The weight of the tower was kept to a minimum. This was important in view of the remote location and difficult haul characteristics of the tower site.

Tubular Steel H Frame. Fixture no. 1 (Fig. 9) is an experimental H-frame type of structure. This installation is unique in that it is made completely of galvanized structural and galvanized tubular steel, 84 feet long.

Electrical clearances to steel were maintained to the same dimensions as those used in the conventional single-circuit steel structure located at position no. 9.

The structural design was based on restricting the length of the individual members to pieces short enough to be handled easily and assembled in the field. Splices are arranged so that the individual pieces of pipe not only are easily transported in rough country, but also can be easily fabricated and galvanized under normal shop practices.

The materials used in the structure are *A*-7 structural steel and standard seamless tube. Couplings and bolts were also made of standard design and were available through normal channels. Should the performance of this structure be satisfactory, it is hoped that high-strength tubing can be used. The weight of such a high-strength tubular structure can then be greatly reduced. The flanges and couplings on the present structure could possibly be replaced by a welded-flange type splice with consequent saving in weight and material cost.

The configuration is similar to a wood H frame, but the loads the structure can sustain are greater than its counterpart. It should be noted that this structure must be classified as strictly an experimental installation. A great deal of engineering investigation will have to be performed before structures of this type can be used on standard transmission lines.

Wood H Frames—Timber Type. Structures 7 and 8, shown in Fig. 10, utilize timbers for cross arms and braces which are equipped with suitable steel fittings for attachment to poles and other timbers, and for support of ground wires and conductors. The cross arms are double timbers 3¾ by 9½ inches by 29 feet 2⅞ inches long, with one on each side of the pole to balance the loads.

Fig. 11. Structure no. 3.

The X braces are 5½ by 9½ inches by 31 feet 5 inches long. The arm braces are double, 3⅜ by 5⅜ inches by 12 feet 7¾ inches long. The upper arm is made up of two timbers 3¾ by 9½ inches by 29 feet long.

The poles at structure 7 are 85-foot class-1 western red cedar and at structure 8 are 80 feet long. Phase spacing is 28 feet.

Structures of this design are statically indeterminate. However, full-scale tests have been made and the framing proved to be adequate. The transverse strength of the structures is designed on the basis of the strength of the poles below the X brace.

Special Wood Dead-End Structures. Structure 3 (Figs. 7 and 11) was designed so that radio choke coils could be inserted in the line conductors. It became very difficult to accomplish a satisfactory result except to make full dead-ends in each phase and support the choke coils and jumpers by suspension insulator strings.

Fig. 12. Last structure (no. 10) in 7,000-foot line, looking toward steel tower (no. 9), a 2,072-foot span.

A 5-pole design was used with heavy steel fittings for supporting the insulator strings. Three poles are 55-foot class-1 western red cedar for supporting the conductors, and two poles are 75 feet long to carry the ground wires and suspension insulator strings for the choke coils.

There are double timber arm assemblies at the tops of the poles and braces for the upper arm. All poles are guyed in the line for support during construction and for unbalanced tensions. Side guys are also provided.

Structure 10 (Fig. 12) is an 8-pole design with two 65-foot class-1 western red cedar poles at each phase and one 80-foot pole for each ground wire.

This is the last structure in the line and must support the full tension. Therefore, all poles are guyed at the tops and midpoints for this loading. Cross-guying is provided for transverse wind forces. Heavy steel fittings are provided at the pole tops for insulator attachments.

Spar-Type Structures. Structures 2 and 4 are of modified design and utilize four spar members (Fig. 6). Two, forming X braces, extend beyond the poles at the point of their top attachment thereto, and secured to the crossarm spars, resist the bending moment exerted by the conductors. Crossarms extend beyond the point of top attachment to the poles to support the overhead ground wires.

This design makes the greatest use of the strength of each spar, since all members have butts down, placing the maximum diameter in each case at the point of maximum load. This is of particular value in contributing to greater transverse strength at the point of botton attachment of the X braces, which is one of the critical points in H-frame structures.

Poles are 85-foot class-1 western red cedar at structure 2 and 75 feet long at structure 4; spar arms are 55-foot larch and X braces are 50-foot larch.

Structures 5 and 6 (Fig. 13) are of the conventional type, utilizing knee and K braces on the crossarm. Poles are 80-foot class-1 western red cedar at 5 and 75 feet at 6; top braces are western red cedar and X braces are larch.

All spars on these four structures are connected with standard galvanized malleable iron hardware available out of the manufacturer's stock. X-brace-to-pole connections utilize grid gains back to back, the timber contacting face being curved to fit pole and spar surfaces. Other spar connections utilize fittings having integral grid gain areas built in. In addition to providng means for secure spar connections, and eliminating wood-to-wood contact and consequent rot, these grid gains, with spurs on the pole side conforming to pole diameters, transfer a large portion of the shear load from the bolt and bolt hole to the surrounding area of wood. By spreading the shear load which must be transferred from one wood member to another over a relatively large area, rather than concentrating it at the bolt hole, a much larger load can be handled safely. In most cases, at normal working loads, these fittings are designed to place the bolt under tension, where it is strongest, rather than in shear.

INSULATORS AND ASSOCIATED HARDWARE

THIS TEST is intended primarily to evaluate electrical characteristics of conductors operating simultaneously at high altitude and extra-high voltage. To avoid clouding the test data, it is desirable that the fittings and accessories have radio interference and corona characteristics superior to those of the conductors.

A secondary purpose of the test is to develop information concerning the general mechanical performance of highly loaded long-span bundled conductors, so the mechanical strength of the tension and suspension devices is intentionally placed well beyond usual practical limits. The safety factors at normal conductor tensions are high, but it is expected that these will be reduced during the life of the test, as modifications to extremely high conductor tensions may be made to precipitate abnormal conductor vibration.

Additional flexibility built into the supporting hardware will facilitate the changing of conductor arrangements so that bundle spacing can be altered or the num-

ber of cables per phase may be altered on the bundle positions.

An additional requirement of the insulators and control rings (for one phase only) is that of complete or nearly complete noise and corona freedom at the highest test voltage.

Numerous laboratory tests have indicated that extension of transmission line voltages to the 500-kv or even 600-kv level would not impose any burden on conventional suspension insulators. As a consequence, little consideration was given to any modification of conventional ASA (American Standards Association) designs for the purposes of this test and no consideration was given to radical departures.

Conventional insulators which are equipped with control rings of usual dimensions exhibit some corona around the pins of the units nearest the line at voltages near the operating level of typical extra-high-voltage lines. This corona is photographically evident in a darkened laboratory. Sensitive radio-influence-voltage measurements will also give evidence of this corona. The noise present at extra-high-voltage operating levels is generally less than 100 microvolts as measured by the NEMA circuit, and represents a totally insignificant amount of interference. Nevertheless, for the purposes of the test line, consideration was given to the preparation of more completely noise-free units in order to remove further the influence of accessory material from the interpretation of the test data. After consideration of all factors, it was decided that commercial insulators would be adequate for the test, using 20 units in each string.

The test conductors, equipped with tapered armor rods, fall within the size ranges of commercial suspension clamps. In addition, the generally short spans at the test site impose little in the way of heavy unit loadings or unusual support conditions. It was therefore decided to utilize commercial suspension clamps in the suspension assemblies. The strain positions are assembled from standard or easily fabricated components.

The control rings are made of extruded aluminum tubing of suitable size to insure that their corona and radio influence performance is superior to that of the test conductors. Figs. 5, 8, 10, and 11 show the suspension, strain, and wave-trap assemblies for each of the three conductor arrangements.

All radio noise values were taken in the Barberton, Ohio, laboratory using the standard test circuit recommended by NEMA, the Edison Electric Institute, and the Radio-Electronics-Television Manufacturers Association, with a coupling condenser consisting of a 4-unit stack of 100-kv 5,000-micromicrofarad units. The radio influence voltage appears across a 600-ohm resistor at the base of this coupling condenser and is measured by a Ferris model *32-B* radio noise meter. In every case, the hardware (not insulators) performed considerably better at sea-level test conditions than the laboratory grade conductor samples.

It is expected that the insulators and associated hardware supplied for the Colorado high-altitude corona test are of a design sufficiently conservative so that radio influence voltage and corona performance of these fittings will not interfere with that of the test conductors.

PARTICIPATING COMPANIES

THE TEST PROGRAM is being conducted under the sponsorship of the Public Service Company of Colorado. The Westinghouse Electric Corporation has contributed the high-voltage transformer and arrester for its protection, the high-voltage disconnect switches, all measuring equipment, and active co-operation in conducting the investigation. A conventional steel tower and an experimental tubular steel H frame tower were contributed by the

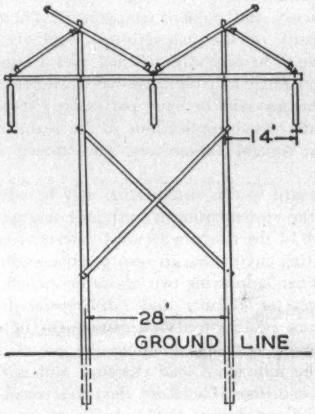


Fig. 13. Wood pole H frame, conventional spar.

American Bridge Division of the United States Steel Corporation. Hughes Brothers, Inc., provided tower arms and fittings for the wood structures, and the Malleable Iron Fittings Company contributed fittings for the spar construction. Insulators and associated hardware were contributed by the Ohio Brass Company. The Aluminum Company of America contributed all conductors and conductor fittings as well as the bus material in the high-voltage substation. The Public Service Company of Colorado provided all poles and spars for the line structures, the substation structures, and performed the line and substation construction.

SUMMARY

IT IS HOPED that the data obtained from this high-altitude corona and r.i. test installation at Leadville will supply the information needed to design practical high-altitude high-voltage transmission lines with assurance of their satisfactory corona, r.i., and mechanical performance. The test facility incorporates many innovations in switching, metering, conductor arrangements, accessories, structure designs, insulator hardware, and other items.

Differential-Feedback Magnetic Amplifiers

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IN PUSH-PULL TYPE magnetic amplifiers with two single-ended external-feedback or self-saturating circuits in back-to-back connection, each of these circuits has its own positive-feedback component which reduces or nearly nullifies the intrinsic negative feedback of the ordinary saturable reactor (transductor). As a result of this fact, the individual quiescent currents of these circuits vary considerably with large changes in supply voltage, frequency, and ambient temperature. Therefore, the characteristics of the magnetic-core and rectifier elements have to be carefully matched over a large part of the working range to avoid excessive asymmetry zero-drift errors. This necessity becomes particularly important in low-level d-c signal applications in the realm of instrumentation, control engineering, and analog computer technique.

With regard to this situation, it may be advisable to abandon the aforementioned push-pull arrangement, in which each of the two single-ended external-feedback or self-saturating circuits has its own positive-feedback component. When employing two separately biased ordinary saturable-reactor circuits and "differential feedback," the resultant positive-feedback component of the magnetic amplifier is proportional to the actual difference between the individual load currents, and is zero with no-signal conditions. Therefore, the two separately biased saturable-reactor circuits retain their inherent negative-feedback properties, and the resultant output current of these circuits is then substantially independent of large changes in supply voltage, frequency, and ambient temperature.

Another approach to the asymmetry zero-drift problem consists in applying "self-balancing" magnetic amplifiers which employ a special combination of external or internal magnetic positive feedback and electric (galvanic) negative feedback. In these amplifiers, positive external feedback or self-saturation produces in effect an infinite internal gain that is highly degenerated by 100% negative feedback, resistance-coupled into the control circuit loop. The drastic reduction of zero drift in self-balancing magnetic amplifiers is the result of combination of the dynamic gain-increasing effect of magnetic positive feedback and the drift-reducing effect of electric negative feedback.

A novel technique for obtaining extreme stability and freedom from zero drift with a minimum of core-matching and component selection consists in applying differential-feedback circuitry to push-pull self-balancing magnetic amplifiers. In this way, it is possible to combine the specific advantages of both artifices and to obtain optimum performance. This is, of course, particularly significant for low-level d-c signal applications and for solutions of those special problems where extremely small values of linearity error and zero drift represent prime requirements.

A typical example for such applications of differential-feedback type, self-balancing magnetic amplifiers is a 60-cycle "magnetic instrument amplifier," particularly well suited for extending the range of application of a standard type, moving-coil ink recorder. Another possibility consists in connecting the input terminals of a current-balance type of magnetic amplifier (acting as a milliammeter without voltage drop) to the moving-coil circuit of a multirange instrument having numerous d-c and a-c voltage and current ranges, without appreciably affecting the calibration of the instrument. In this case, the moving-coil ink recorder in the output circuit of the magnetic amplifier covers all the d-c and a-c voltage and current ranges of the multirange instrument.

The relationship between power gain, linearity error, and response time of differential-feedback type magnetic amplifiers is such that if one property is accentuated, it is always at the expense of the other properties. Actual response time of these amplifiers may be reduced to its minimum value of one half-cycle of the power-supply frequency by introducing 100% negative feedback without employing any rectifier components in the control circuit.

Special applications are concerned with the use of nonlinear or frequency-sensitive components in the negative-feedback network of the self-balancing magnetic amplifier. A capacitor or a mutual inductance may be introduced into the negative-feedback channel of this amplifier to perform the integration or differentiation of a variable directly with respect to time.

Differential-feedback type, self-balancing magnetic amplifiers can also be used in combination with phase-sensitive rectifiers for the measurement of various a-c quantities, for example, in a-c bridge and potentiometer networks. Voltage dividers and shunts may be provided to extend the a-c voltage and current ranges.

In the fields of telemetering and automatic control, these amplifiers will undoubtedly find numerous interesting applications because of their distinct advantages over other d-c amplifier systems based upon the use of high-sensitivity galvanometers or vacuum tubes. With regard to applications in analog-computer technique, full advantage is taken of the specific properties (extreme stability, linearity error is about 1/10% or less). Nonelectric quantities will be measured by conventional types of "transducers," which provide the desired transition into an electric value.

Digest of paper 57-92, "Self-Balancing Magnetic Amplifiers of the Differential-Feedback Type," recommended by the Committee on Magnetic Amplifiers and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Communication and Electronics*, 1957.

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Detection of Faults in Power Transformers

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ALTHOUGH recent improvements in design, construction, installation, and maintenance of power transformers have made them notably trouble-free, faults do occur, and the possible consequential damage of a failure is sufficiently severe to justify very careful consideration to the detection of faults.

Devices have been devised to detect faults in some of the auxiliary features of the transformer, such as oil pumps, fans, oil level and temperature, but the most extensive thought has been given to the final serious fault which is an insulation failure in the winding. The most elementary form of failure, one which should be detected before the fault develops into a more serious failure, is the short circuit of a single turn.

Two primary methods of detection of such a fault are (1) measurement of the gas formed at the arc usually developed at the point of failure, and (2) measurement of the unbalance in input and output ampere-turns by means of differential relays.

Common types of gas detection devices are (1) the gas-accumulator relay, which can also measure rate of gas formation, used in conservator-tank transformers, (2) the rate-of-pressure-rise relay which measures only rate of rise of gas pressure in a transformer with gas cushion above the oil, and (3) straight pressure devices, including the pressure-relief device with alarm contacts.

The differential relays are handicapped by the necessity that they do not operate during magnetizing inrush (which appears as a fault) or when taps are changed. In addition, the relays must be restrained by using the harmonic current or d-c component of the inrush current, or desensitized.

The fault current due to a single short-circuited turn can, of course, take a number of different values depending on the particular transformer and the particular turn. However, an analysis based on short circuit of the turn which will give the least fault current has been made on a large number of transformers and found to follow an approximate pattern which can be described by the curve in Fig. 1. The fault current on the line side of the transformer is found by dividing the product by the impedance of the transformer. It must be noted that these curves are based on a 75-volt arc and, therefore, indicate that transformers below about 10 mva have no fault currents. Curve 1 shows a low-voltage short-circuited turn, with the low-voltage winding loaded and high-voltage winding energized. Curve 2 shows a high-voltage short-circuited turn, with the high-voltage winding loaded and low-voltage winding energized.

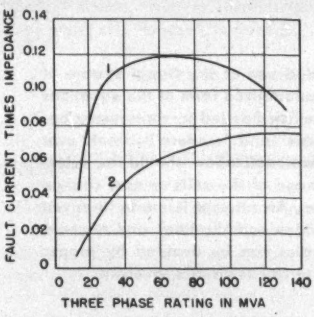

Fig. 1. Fault current—impedance product for single turn-to-turn short circuit.

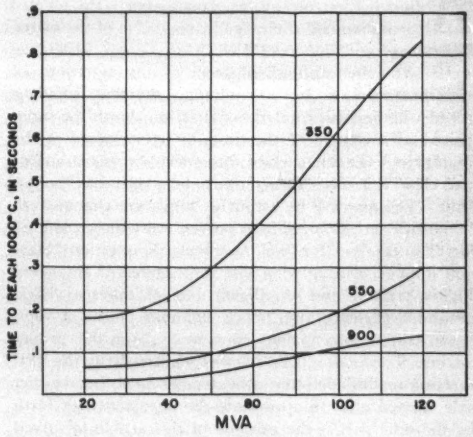

Fig. 2. Time for the copper in the short-circuited turn to reach 1,000 C, the melting temperature of copper, for various BIL values.

The short-circuited turn heats very rapidly, according to Fig. 2, which is based also on the analysis of a number of transformers. The fault current in the shorted turn is larger for the higher BIL values because the turns ratio is larger. Thus, the melting temperature is reached in a short time for the higher BIL values.

Most of the available relays will provide reasonably good protection against severe consequential damage. The harmonic-restraint relay gives adequate protection, although harmonic currents in the fault current due to the arc characteristics may interfere to some extent, while some plain induction disk relays and the pressure-relief device primarily furnish back-up protection.

Digest of paper 57-21, recommended by the AIEE Committees on Transformers and Relays and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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Does Rationalization Change Units?

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The recommended use of the Giorgi system of units with the rationalized form of the equations of electromagnetism has led to controversy between the "classic" and "modern" schools over whether total rationalization should be interpreted as a change of the units or as a change of the quantities. An attempt is made to unveil some of the hidden complications and to show how the difficulties can be avoided by proper attention to the semantics involved.

AT ITS 1 9 0 MEETING IN PARIS, the International Electrotechnical Commission (IEC) voted to recommend the usage by engineers of the meter-kilogram-second-ampere (MKSA) or Giorgi system of units with the rationalized form of the equations of electromagnetism. In an unhappy moment someone asked whether this total rationalization should be interpreted as a change of the units or as a change of the quantities.[1] On the surface this query seems reasonable and clear, but it has turned out to be a veritable "booby-trap." To answer it by a concise "units are changed" or "quantities are changed" has proved every bit as misleading as to say "yes" or "no" to the classic question "Have you stopped beating your wife yet?" Different engineers, highly trained and intelligent but of different background experience and, hence, different points of view, have drifted into violent controversy over the proper answer. The matter was debated vigorously at the IEC meeting in Philadelphia in September 1954, but neither side seemed able to appreciate the arguments set forth by the other.[2] It is the purpose of this article to unveil some of the hidden complications and to show how the difficulties can be avoided by proper attention to the semantics involved.

RATIONALIZATION

OF THE THREE KEY WORDS: "rationalization," "units," and "quantities," the relatively strange word "rationalization" might at first be suspect, but is quite innocent. In the present context this word has a highly specialized meaning, originally conferred on it in 1882 by O. Heaviside. It signifies the setting up of the equations of electromagnetism in a new and more "rational" form, so that the factor 4π appears in those equations which relate to configurations having spherical symmetry, but is absent from those applicable to rectilinear configurations. Although the equations currently proposed are not those originally suggested by Heaviside, no serious challenge has arisen to these changes in the equations, and the confusion is limited to the changes in units or in quantities which are a necessary by-product.

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NOTATION

IN THE VERY FIRST PARAGRAPH of Maxwell's classic treatise on electricity and magnetism, he sets forth explicitly the generally accepted relation that any physical quantity can be regarded as the product of a pure number multiplied by a standard quantity of the same kind. The conventionally chosen standard quantity he calls the "unit" and the numerical multiplier is often called the "measure" of the quantity considered. He also introduced the notation $[L]$ to designate the unit of length, so that a particular quantity of the nature of a length could be written

$$L_n = \{L_n\}_a [L]_a \tag{1}$$

Here the symbol $\{L_n\}_a$ represents the measure of the particular quantity L_n in units of the system of measurement identified by the subscript $_a$. With this notation each "measure equation" which expresses the relation between the measures of the quantities involved strictly should be written with $\{\ \}$ signs enclosing each quantity symbol. The similar equation with the $\{\ \}$ signs omitted would then be considered a "quantity equation." The individual symbols in a measure equation represent pure numbers, while those in a quantity equation represent physical quantities.

Consider, as an example, the simple equation which relates the magnetic field strength H_s at the center of an elongated, uniformly wound solenoid, with the current I_s in its winding and with the pitch L_s at which its turns are spaced. This equation (in its unrationalized form) is commonly written

$$H_s = 4\pi \frac{I_s}{L_s} \tag{2}$$

the subscript $_s$ indicating that this equation refers to the particular case of an elongated solenoid. In the rationalized form the relation is written

$$H_s = \frac{I_s}{L_s} \tag{3}$$

Similarly, the more limited "measure equations" which relate the measures of these quantities in the non-rationalized (subscript $_n$) and rationalized (subscript $_r$) systems, respectively, are

$$\{H_s\}_n = 4\pi \frac{\{I_s\}_n}{\{L_s\}_n} \tag{4}$$

and

$$\{H_s\}_r = \frac{\{I_s\}_r}{\{L_s\}_r} \tag{5}$$

All agree that rationalization involves no change in either of the quantities I_s and L_s or in their units or their measures. Hence,

$$\frac{\{I_s\}_r}{\{L_s\}_r} = \frac{\{I_s\}_n}{\{L_s\}_n} \tag{6}$$

and

$$\frac{[I]_r}{[L]_r} = \frac{[I]_n}{[L]_n} \tag{7}$$

PARADOX

THOSE ENGINEERS who prefer to regard the equations of electrodynamics as measure equations proceed to combine equation 6 with equations 4 and 5 and derive

$$\{H_s\}_n = 4\pi \{H_s\}_r \tag{8}$$

To them H_s always symbolizes the same physical phenomenon which must be independent of the measurement system used to describe it. Hence, it is the same on both sides of equation 8. They therefore conclude that because the two measures of H_s differ by a factor of 4π the units involved in measuring H_s must differ inversely by this same ratio, and hence they write

$$4\pi [H]_n = [H]_r \tag{9}$$

On the other hand, those who prefer to regard the equations of electrodynamics as "quantity equations" compare equation 2 with equation 3 and conclude that equation 2 must necessarily define H_s as symbolizing a quantity which is greater by the factor 4π than the quantity symbolized by H_s in equation 3. They would say that this distinction should have been indicated by writing H'_s in equation 3. Also they divide equation 2 by equation 4 and equation 3 by 5 and on applying equation 7 get

$$[H]_n = \frac{[I]_n}{[L]_n} = \frac{[I]_r}{[L]_r} = [H]_r \tag{10}$$

Equation 10 is in direct contradiction to equation 9 and shows that the unit of H is unchanged by rationalization.

THE TWO POINTS OF VIEW

THE CONFLICT between the two contradictory answers to the original question, namely (1) "units are changed" or (2) "units are not changed" by rationalization, obviously arises from the difference in the two points of view from which different writers view the question.

Ardent proponents of either point of view display this contradiction as evidence that the other point of view must be "incorrect" or at least less preferable than their own. It seems to the writer, however, that the real difficulty is primarily semantic and results from attributing two distinctly different meanings to the word "unit" (and also to "quantity") by the opposing camps.

The differences between the two schools of thought are rooted very deep in the habits of thought of the writers. In general, experimentalists and engineers tend to the "classic" school, whereas theoreticians and mathematicians prefer the "modern" approach.

THE CLASSIC APPROACH

FROM THE OLDER CLASSICAL POINT OF VIEW, each quantity (usually called a physical quantity) is thought of as representing very completely and immediately all of the significant features of the actual natural phenomenon which it represents. Here such a concept will be called a "concrete quantity." A specific example of each concrete quantity which is used as a unit to measure concrete quantities of the same kind will be called a "concrete unit." Classical writers, when indicating the relation between different physical phenomena by means of equations using the symbols appropriate to the concrete quantities involved, consider that the letter symbol used symbolizes merely the measure of the concrete quantity in terms of the concrete unit. Since the symbols represent pure numbers there is no question of the validity of applying algebraic operations to these symbols. By contrast, the close visualization of the quantity as possessing the physical attributes of the phenomenon it represents renders abhorrent the idea of performing algebraic operations with symbols which signify concrete quantities.

Where the symbol $\{X\}_a$ is used in this article to indicate the measure of concrete quantity X in the system $_a$, classical writers normally use merely the simple symbol X. Some writers think of the measure equation in its usual form as merely a short-hand expression for the more rigorous form which would use the braces and subscript $\{\ \}_a$. Others regard a physical equation written without the braces as being more general and as encompassing in a single line the plurality of all the similar more rigorous forms which might have been written for all possible sets of units. Such authors often write after such an equation the precautionary phrase "true in any consistent set of units."

In the development of a set of physical relations, the introduction of each new concrete quantity is naturally formalized by writing a defining measure equation. In this, the measure in a new tentative concrete unit of the new concrete quantity appears alone on the left side of the equation, while the combination of the measures of a plurality of other concrete quantities already defined and on which the new concrete quantity is dependent appears on the right side, together with a numerical coefficient. This coefficient is often called the "defining constant" of the new quantity. Its value depends (1) upon the particular physical or geometrical situation for which the equation is applicable (for each different situation the defining constant will differ by a corresponding numerical factor); (2) upon the concrete units already used in setting up the measures of the known concrete quantities on

the right side; and also (3) upon the tentative concrete unit used to obtain a preliminary quantitative measure of the new concrete quantity on the left side. If one assumes that all the quantities on the right side have been measured by a consistent set of concrete units, the next operation is to determine the concrete unit which will be appropriate for measuring the new concrete quantity. The first step is to assign a desired conventional value to the defining constant. This constant is usually, but not necessarily, taken as being unity for some particular simple geometrical situation. Consider now this same particular geometrical situation in the case when the known concrete quantities whose measures appear on the right side of the equation have such values that the complete right side of the measure equation has a value of unity. The example then existing of the new concrete quantity on the left side of the equation is an embodiment and definition of the new concrete unit which is germane jointly to the system of concrete units defined earlier and also to the equations for various geometrical situations, each with its appropriate definitional constant. Thus, for example, consider the measure equation in the cgs (centimeter-gram-second) system for kinetic energy w for the particular situation of a mass m moving with a velocity v,

$$\{w\}_{cgs} = \frac{1}{2} \{m\}_{cgs} \{v\}^2_{cgs}$$

Here the definitional constant is ½. The concrete unit (the concrete erg) is the energy possessed by a mass of 2 grams moving with a velocity of 1 centimeter per second. By successive application of this process a complete set of concrete quantities, equations and concrete units germane to both can be developed. Each such definition of a concrete unit involves a reference to some particular physical and geometric situation, but the resulting concrete unit is independent of the particular situation chosen and is identical with the concrete unit which would have been defined if any alternative situation had been used. Thus, the concrete erg may alternatively be defined as the work done by a force of one dyne acting through a distance of one centimeter.

THE MODERN APPROACH

By contrast with this, on the modern point of view, each physical quantity is considered on a higher level of abstraction more remote from the physical phenomenon which it represents. These abstract quantities can by definition have attributed to them the property of being subject to algebraic operations. A proof based on group theory for the possibility of establishing such a self-consistent set of quantities has been developed by M. Landolt.[3,4] As each new abstract quantity is introduced, a new quantity equation serves to define the new abstract quantity as the result of algebraic operations upon the abstract quantities already postulated or derived.

The abstract units in terms of which these abstract quantities are measured may be defined in either of two ways. In the first way, a situation is imagined in which the quantities on the right side of the quantity equation, which defines the new abstract quantity, have such values that the complete right side including the definitional constant has the measure unity. The abstract quantity on the left side will then constitute an example of the abstract unit appropriate for measuring the new abstract quantity.

Alternatively, the abstract units may be defined in a second way. In the fundamental units of the system, each unit is considered as an example of an abstract quantity, and each is raised to an appropriate positive or negative power (the exponents being the dimensions of the derived abstract quantities in terms of the respective fundamental quantities) and the results are then multiplied together to form the abstract unit; e.g., 1 abstract erg = 1 gm^{+1} cm^{+2} sec^{-2}). Such a set of abstract units is designated as a coherent set if no numerical coefficient, other than unity, appears in the unit equation. Each abstract unit depends both on the fundamental units chosen and on the dimensions of the abstract quantity of which it is the unit, but is independent of the defining constants in the equations of the system. It should be noted that the "unit equation" which defines an abstract unit should not be misinterpreted as the definition of a concrete unit; e.g., the erg is not the energy of 1 gram moving with a velocity of 1 centimeter per second.

A true quantity equation expressing the relation between abstract quantities has the elegant property of being valid without regard to units. This follows from the fact that for each quantity considered separately, any change in the abstract unit used to measure it produces a compensatory change in the measure of the abstract quantity, leaving the product of unit and measure (abstract quantity itself) unaffected. However, it is only when the abstract units form a coherent set that the measure equation has the same form and coefficients as the quantity equation.

It may be noted that the three concepts "dimension," "abstract unit," and "concrete unit" form a progressive sequence. Each in succession contains more specific information than its predecessor. Thus for energy we have the sequence:

Dimension	Abstract Unit	Concrete unit
ML^2T^{-2}	: gm^{+1} cm^{+2} sec^{-2}	: energy of 2 grams at 1 cm per second

The intermediate abstract unit is automatically changed appropriately in value by changes in the size of the fundamental units but is not changed by changes in the definitional constant.

APPLICATION TO RATIONALIZATION

The process of rationalization is, in effect, merely a somewhat arbitrary change in the definitional constants in certain of the equations of electrodynamics. It is tacitly assumed by the classical writer that such an action should not be considered as affecting the much more fundamental correlation between each of his concrete quantities and the unchanged natural phenomenon which it represents. However, the changes in the definitional constants

in the measure equations, which describe the natural phenomena and which also serve to define the germane concrete units, necessarily result in changes in the germane concrete units.

Conversely the modern writer, noting the change in the definitional constant of his quantity equation, naturally chooses to regard this as defining a new and different abstract quantity to represent in the new rationalized system the same old unchanged natural phenomenon. The coherent set of abstract units, depending as it does only on the fundamental units, will not be changed. If these abstract units were originally coherent, the new measure equation in terms of the unchanged abstract units will contain the new definitional constant and will be identical with the measure equation as written by the classical writer and also will be in the same form as the quantity equation written by the modern writer. This identity in form of the measure and the quantity equations is of course very desirable. The adjective "total" was applied to the noun "rationalization" in the IEC resolutions of 1950 to signify this identity.

CONCLUSIONS

IT IS EVIDENT from the foregoing discussion that the answer to the question in the title is: The process of total rationalization (1) does change the coefficients in certain measure equations; (2) does change the coefficients in the corresponding quantity equations; and from the "classic" point of view, (3) does not change any concrete quantity; but (4) does change certain concrete units; while from the "modern" point of view it, (5) does change certain abstract quantities; but (6) does not change any abstract units.

The more general problem which confronts physicists and electrical engineers today is not so easily solved. Of course, the majority of technical treatises can be read and interpreted from either of the two views without difficulty. Some individuals, recognizing that either point of view is valid and, if strictly followed in any particular case, will lead to a correct result, recommend that "sleeping dogs be allowed to lie" and that each school continue to write books and articles as if in blissful ignorance of the other. On the other hand, when the two habits of thought become mingled in a single discussion the resulting confusion may lead to a serious waste of time and temper, as illustrated by the current discussions in international meetings. Moreover, consider the engineering student introduced to electrodynamics by a modern text which says 1 oersted = 1,000 ampere-turns per meter and then reading in a classic reference work that 1 oersted = $1{,}000/4\pi$ ampere-turns per meter. It is regrettable that the distinction was not recognized a long time ago, and that the two meanings of "unit" were not initially distinguished either by adjectives or better by using a different term such as "monad" for what is here called "abstract unit." It is, however, not too late to publicize the existence of the two habits of thought and to warn the unwary of the pitfalls between them.

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Mortar Spotter

The Army's newest radar mortar locator that can spot the location of enemy mortar fire is set up in the field by Pvt. E. Rhodes (foreground) of New Britain, Conn., and Specialist 3rd Class S. Humes, New Paris, Pa.

The new finder was developed at the U.S. Army Signal Corps Engineering Laboratories, Fort Monmouth, N.J., and built by the General Electric Corp. Rhodes adjusts the scanner before operation while Humes emerges from the hood covering the operating console after taking a rapid reading of the enemy's mortar location.

Faster, more accurate and more compact than a similar instrument used in the Korean conflict, the locator uses a new beam technique to spot an enemy mortar. When the radar scopes' cross hairs are centered on the blips made by the mortar round passing through the set's beams, a direct reading of the offending weapon's location is recorded.

An Inductronic Double Bridge

J. H. MILLER

FELLOW AIEE

Using inductronic d-c amplifiers, a method has been developed for measuring low resistance values with a minimum of manipulation. Advantages include high accuracy, speed, and simplicity of operation.

THE KELVIN OR DOUBLE BRIDGE is considered the standard type of bridge for the measurement of very low resistance values and, more specifically, where four terminal resistances are used. Typical examples are in the comparison of shunts which are basically 4-terminal resistors and in the measurement of conductivity where the current terminals are at the ends of the wire or bar under consideration, and the millivolt terminals are between those current terminals.[1,2,3]

The Kelvin bridge involves somewhat more elaborate circuitry than the simple Wheatstone bridge although the form using multiple-deck dial switches partially simplifies the manipulation. Nevertheless, this general arrangement appears necessary where the bridge current must flow through low-value resistors in series as two adjacent bridge arms, and which have an anomalous resistance between them. Frequently the voltage drop between the two resistors is larger than the drop in the resistors themselves, and essentially the Kelvin bridge provides an appropriate return point for the galvanometer.

In the adjustment of shunts, the Kelvin bridge has been used rather consistently. However, the manipulation required along with appropriate maintenance of the equipment is not as simple as is desirable in the manufacturing plant.

DEVELOPMENT OF THE METHOD

WHEN A SHUNT or other low-valued resistor is to be adjusted in terms of the resistance of a standard, it is obviously possible to pass a current through the two resistors in series and compare the voltage drop across them. And, theoretically, if we could obtain directly the *ratio* of these drops, we could at once determine the resistance of the test shunt in terms of the standard. But inasmuch as the two voltages to be compared are not only small, but also are separated by a larger anomalous voltage, it would appear that they can only be compared in the Kelvin network or in a 2-coil ratio meter of rather limited sensitivity.

To simplify the measurement procedure in the production of such low-valued resistors or shunts, consideration was then given to the possibility of amplifying the millivolt values by means of d-c amplifiers, where there is no internal connection from the input to the output terminals, and which would allow the amplified millivolt values to be compared in an accurate manner, perhaps in an interconnected network. Amplifiers embodying a mechanical link in the amplifying chain would function in this way, as would those where the signal is converted to an alternating current, amplified with transformer coupling, and phase-rectified back to direct current or potential. And where such amplifier systems operate with full feedback through a mutual resistor, very high accuracy of gain is possible.

The inductronic system described by Gilbert[4] is of this type, wherein a d-c input is converted into alternating current, amplified, phase-rectified, and in the usual form the output is fed back through a mutual resistor to balance the input completely. The amplifier, in essence, only amplifies the unbalance or error component. As applied to the problem at hand, one feature of the inductronic system is that with a millivolt input and a proportional milliampere output, that output will remain truly proportional to the input without regard to the resistance loading in the current output circuit, provided the IR drop in that output circuit is less than 5 volts. Since less than 5 volts would be used across the low-valued resistors in series, it is thus possible to tie the two outputs together in any of several types of ratio indicators.

As with many other d-c amplifiers the current output of the inductronic amplifier is somewhat limited and normally considered as 1 milliampere maximum. This is a rather small current value for a pivot-type ratio meter, so the preliminary study envisioned the use of a servo-type ratio meter where the ratio of the two currents, balanced against a ratio obtained from a motor-driven slide wire, resulted in a difference signal which, being amplified, balances the motor. This is essentially the mechanism of a typical ratio recorder.

It was also considered advisable to determine whether the shunt under test could be matched to a standard shunt having some other rating. When balanced, unity would be indicated on the ratio meter and the test shunt would be correct. This apparently could be arranged by adjusting the feedback resistance in one of the amplifiers.

CIRCUIT DETAILS

THE FIRST CIRCUIT which evolved is shown in Fig. 1. The 50-ohm resistor at the left is the amplifier feedback or coupling resistor, and is of good accuracy; R is the feedback resistor in the test shunt amplifier. The two 1,000-ohm resistors bridging the potential terminals of

Full text of paper 57-111, presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Recommended for publication by the AIEE Committee on Indicating and Integrating Instruments.

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the two shunts merely serve as return circuits for the amplifier output currents; they are nominally alike since, with unity ratio of these currents, the anomalous voltage across them to be absorbed in the amplifier output circuits is evenly divided. Lower values can be used, and the circuit will function correctly even if one of these units is reduced to zero. Where multiple leads to shunt potential connections are shown, it is important that these be completely independent up to the potential terminals. In practice, the several leads are soldered in adjacent holes in a relatively heavy copper lug clamped to the potential terminal on the shunt.

When 50 millivolts appear across the standard shunt and the associated amplifier, it causes the output current to rise until the IR drop of this current through the feedback resistor balances the 50-millivolt value. Thus, on applying the 50-millivolt input, the output current in M_1 rises to 1 milliampere and holds this value. The transconductance of the amplifier with a 50-ohm coupling resistor could be considered 20,000 microhms, or the reciprocal of 50 ohms.

Similarly, in the amplifier network connected to the test shunt, for 1-milliampere output to balance 50 millivolts, R must be 50 ohms. This would be the circuit condition if the test shunt were exactly equal to the standard, and the ratio meter would then indicate unity. If the test shunt is 10% (per cent) low in resistance, giving 45 millivolts under the same conditions, 0.9 milliampere will be developed in the output and the ratio meter will indicate 0.9, or that the test shunt is 10% low in resistance. Presumably the shunt would then be adjusted to unity on the ratio meter.

Alternatively, if the test shunt has twice the current *rating* of the standard shunt (for 50 millivolts drop), or half the resistance, then with current to produce 50 millivolts in the standard shunt there will be only 25 millivolts in the test shunt. And to get a balance or a unity ratio indication that the test shunt is correctly adjusted, R becomes 25 ohms so that the 1-milliampere output produces 25 millivolts through R. In other words, at unity

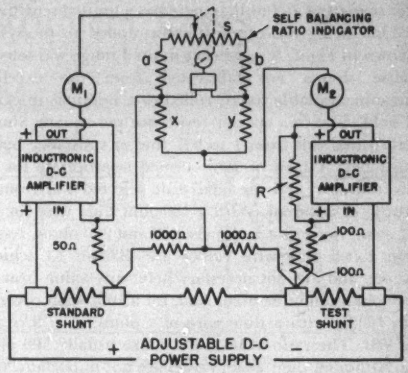

Fig. 2. Inductronic double bridge with a self-balancing ratio indicator of limited range.

ratio or balance of the output current of the two amplifiers,

$$\frac{\text{Test shunt resistance, ohms}}{\text{Standard shunt resistance, ohms}} = \frac{R}{50} \tag{1}$$

Then for a unity indication of the ratio meter showing the test shunt to be correctly adjusted to its rated value

$$R = 50 \text{ (Test shunt ohms)} / \text{(Standard shunt ohms)} \tag{2}$$

Alternatively, in terms of shunt rating in amperes for the same millivolt values,

$$\frac{\text{Standard shunt rating}}{\text{Test shunt rating}} = \frac{R}{50} \tag{3}$$

or

$$R = 50 \text{ (Standard shunt rating)} / \text{(Test shunt rating)} \tag{4}$$

Since, as stated previously, a direct-reading d-c ratio

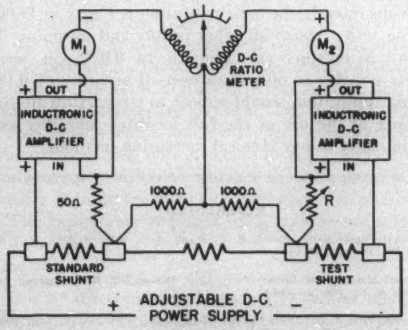

Fig. 1. Inductronic double bridge with an indicating ratio meter.

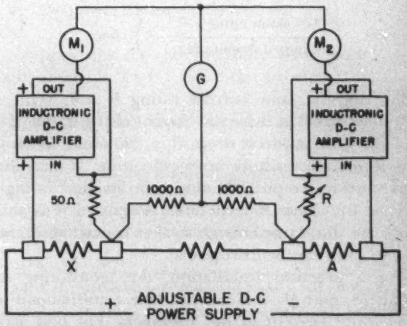

Fig. 3. Inductronic double bridge with a galvanometer balance indicator.

meter operating at 1 milliampere has a limited sensitivity, a self-balancing ratio indicator was added to the system as shown in Fig. 2. A somewhat limited range was selected because shunts are fabricated from the excellent manganin available today, rolled to a nominal thickness and held close to a specific resistance per square. Shunts as fabricated run from 1 to 5% low in resistance before adjustment. A span of 10% seemed appropriate for the ratio indicator, and the final scale selected was from 92 to 102% of nominal. With a 100-ohm slide wire for the 10% span, resistors a and b are 920 and 980 ohms, respectively. Exact slide-wire values are difficult to achieve, however, and are not necessary here; any value from 50 to 200 ohms might be used. And, for a 10% span covering 92 to 102%, with a slide wire of s ohms, $a = 9.2s$ and $b = 9.8s$. The ratio arms x and y are usually 500 ohms each. Although their exact values are not important, they must be equal to each other to better than 0.02%. To arrange for the checking of a shunt having some ratio of other than unity to the standard shunt, the network at the right must be variable. Because this requires contacts, the network was changed as shown. Here the potential in millivolts balancing the test shunt millivolt drop is

$$i_{ma}\frac{100 \times 100}{R + 200} \tag{5}$$

or for 1 milliampere output current, is $10{,}000/(R + 200)$. To balance 50 millivolts, R then is zero, and this will balance the 50-ohm coupling resistor associated with the standard shunt. This particular arrangement assumes that the test shunt will always have a rating higher than the standard shunt, a rather desirable procedure in practice. At an output unity current ratio we then have, from equation 3

$$\frac{\text{Standard shunt rating}}{\text{Test shunt rating}} = \frac{10{,}000/(R + 200)}{50} = \frac{200}{R + 200} \tag{6}$$

or

$$R = 200\left(\frac{\text{Test shunt rating}}{\text{Standard shunt rating}} - 1\right) \text{ ohms.} \tag{7}$$

Thus, for the same current rating $R = 0$; while for a test shunt rated at twice the current of the standard shunt (for the same millivolt drop) $R = 200$ ohms. With standard shunts or resistors in decade steps, R may have a maximum value of 2,000 ohms; the smallest rating ratio will be 1.2, where $R = 40$ ohms. Values of R in this network are thus large enough so that contact resistance up to 0.01 ohm can be disregarded.

For a practical installation, the monitoring instruments M_1 and M_2 indicate on their 1-milliampere scales the output current of the amplifiers. For best accuracy the main current is adjusted until approximately 1 milliampere exists in the output. This is important because these amplifiers fail to be proportional due to overloading at about 2 milliamperes. By the same token, with a given resolution best accuracy is obtained with an adequate input level.

CONCLUSIONS

EQUIPMENT FOR CHECKING SHUNTS as described has been built and functions in a satisfactory manner. Accuracy is excellent. If all power is disconnected and the pointer of the ratio indicator is moved manually to a different position, when current is again applied, the previous value is indicated to within 0.05% on the scale. Shunts adjusted using this equipment have been found to check on a conventional Kelvin bridge to better than 0.10%. As a practical matter, the simplicity of operation of the measuring gear has resulted in more accurate shunt adjustment even with the same allowed tolerances.

It was pointed out previously that the results are independent of the loading of the amplifier output, provided the drop was not over 5 volts. To prove this, as much as 6,000 ohms of resistance was arbitrarily added to one of the output circuits before any change in the indication became evident.

Although the full 1 milliampere in the output of the amplifiers is desirable, with the available resolution in the amplifiers 0.10% accuracy can still be maintained at as low as 1/10 nominal rated current (0.1 milliampere in the amplifier output), which allows for adjusting and checking shunts rated at 50,000 amperes and using a 5,000-ampere power supply.

For use as a resistance-measuring bridge, the arrangement in Fig. 3 is suggested, with a decade box substituted for R of Fig. 1 and a null galvanometer G used as a balance indicator. With R adjusted to indicate a null, and with a 50-ohm coupling resistor as shown in the left-hand amplifier then, $X = 50\ A/R$.

This general arrangement appears to be a rather powerful method for measuring low resistances in a straightforward and direct manner to a good degree of accuracy. The resolution of the amplifiers is less than 5 microvolts. If sufficient current is put through the resistor under test and the standard to produce about 50 millivolts in each, the basic resolution is 1 part in 10,000. Taking into account all other factors and assuming the important resistors are adjusted to 0.02%, it seems readily possible to obtain an over-all accuracy of 0.1%.

This application would appear to stress again the importance of the use of the full feedback amplifier as a link in many of our classical measuring methods.

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Compensation for Instrument Losses

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THE RELATIVE LOCATION in a circuit of a wattmeter, voltmeter, and ammeter generally requires careful consideration. The wattmeter reading will be greater than the load power by the power loss in the potential circuits or the current circuit, depending on the connection used. Ammeter or voltmeter readings will also differ for the same reason from the load value they should represent.

Internal wattmeter compensation, available in the better quality instruments, does not compensate for the voltmeter loss and permits the ammeter current to remain in excess of the load current. Internal wattmeter compensation then leaves something to be desired when the objective is to obtain instrument readings that represent load quantities.

The wattmeter reading may be corrected either by computing the loss in the potential circuits (or the current circuit, as the case may require) or by measuring the losses by means of a tare reading. In those instances when the instrument losses are a significant proportion of the wattmeter reading, an error in the determination of these losses, or in the calibration of the instrument, results in a larger error in the computed load power. In general, the correction for the ammeter or voltmeter reading (whichever is in error), though possible, is laborious.

Whenever load phase angle or a-c resistance is desired, the accuracy may be lowered by errors for which correction is impossible. A means of compensating for these errors so that the instrument readings would all simultaneously represent load quantities is advantageous.

A circuit proposed by L. L. Shumaker and G. A. Neyhouse, attempts to compensate for the errors mentioned. The circuit causes a negligible ammeter error but the wattmeter error may be serious at low power factor loads.

The circuits shown in Figs. 1 and 2 use a detector D to reduce the inherent circuit errors to zero. In each circuit, the voltage drop in the current circuit is duplicated across impedance Z_c. Detector D is used in the adjustment of Z_c as a null detector to indicate when the load and potential circuit voltages are identical. The detector can be any low-range vacuum-tube voltmeter or equivalent.

The compensating impedance, Z_c in Fig. 1 is capacitive or inductive depending on whether the load phase angle is greater than or less than the current-circuit phase angle. The capacitance required in Z_c may be reduced by modifying the circuit shown in Fig. 1 in any of the following ways:

1. An air cored inductance with a Q greater than the Q of the current circuit (ammeter plus wattmeter current coil) can be inserted in series with the current circuit arm of the bridge.

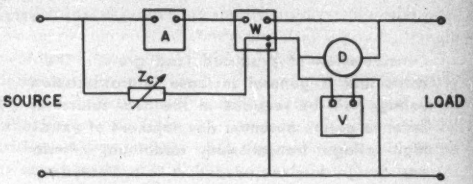

Fig. 1. Bridge-circuit compensation with potential-circuit current.

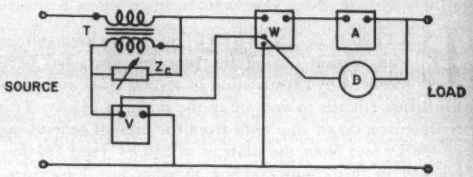

Fig. 2. Bridge-circuit compensation with line current.

2. An instrument potential-transformer energized from the line and with its secondary connected in series with Z_c will require that Z_c have a large resistive component. The required capacitance effect can be produced with a relatively small value of parallel capacitance.

3. If the aforementioned potential transformer is replaced by a phase shifter, Z_c can be reduced to a pure resistance.

CONCLUSIONS

1. The circuit proposed by Shumaker and Neyhouse, is convenient to use because it relies on only one adjustment of the compensating impedance regardless of load conditions. The wattmeter error in this circuit may be serious at low power factor loads but the error can be computed.

2. If compensation for the wattmeter error is desired, the circuits shown in Figs. 1 and 2 can be used to advantage.

3. The compensating impedance of Fig. 1 varies with the nature of the load impedance, whereas the impedance used in Fig. 2 is a function of the current-circuit impedance. Thus, for the latter circuit an impedance can be constructed for use with a rather large number of different instruments, regardless of the nature of the load.

Digest of paper 57-43, "Compensation for Instrument Losses in Circuits Containing a Wattmeter, Voltmeter, and Ammeter," recommended by the AIEE Committee on Indicating and Integrating Instruments and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Communication and Electronics*, 1957.

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The Need for Research on Transmission Limitations

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Consideration of predicted load growths indicates that a general increase in transmission voltage will be required in the near future. In order to assure optimum development of extra-high-voltage transmission, additional criteria and design data are needed. A co-ordinated research program is proposed.

EXTENSIVE INTEREST in extra-high-voltage transmission during the past few years has been followed by construction of several lines and plans for future circuits to operate in the range of 345 kv. This represents a major step both from the present general use of 138 kv and from the plateau of 230 kv (and 287 kv) reached in this country about 30 years ago. Experience records from lines operating at the new voltage level will be important in establishing confidence in further designs for 345 kv and higher voltages to meet the requirements for greatly increased transmission capabilities.

Results of tests and studies may be expected also to supplement the experience records in the normal course of development. However, complacency may cause delays that will later prove costly unless some present factors are more generally realized. Additional criteria and design data of a basic nature are needed to assure optimum development of extra-high-voltage transmission. The potential value justifies engineering and management decisions to develop these data promptly by concerted effort.

Consideration of the load growths that are predicted indicates that a general increase in transmission voltage will be needed soon. Current developments in steam generation, turbine–generator sizes, and transformers are far ahead of transmission in unit load capabilities. Within a very few years, these increased ratings will be economically feasible and advantageous for many utility systems now using average size generating units.

In addition to development of higher voltage designs for overhead construction, there will be a need for even greater steps in development of high-voltage cables. The project now being started for field testing of new cable designs for use in the 345-kv range will benefit applications at lower voltages also, and results probably will be obtained none too soon. The industry approach to this problem might well serve as a model for the investigations which are needed in overhead transmission.

Revised text of a conference paper presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Recommended for publication by the AIEE Committee on Research.

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NEEDED IN 10 TO 15 YEARS

THE RATE OF GROWTH of power loads in the United States could reduce from the rate of the past and still point to an increase in generating capability requirements in the order of two to three times the present annual additions within the next 10 to 15 years. Forecasts of steady industry growth place the total plant capacity at double the present in 10 years and triple in 15 years, while the minimum estimates would double the capacity in 15 years.

There are about 30 utility systems in the United States with present total generating capacity over 1 million kw; another 30 systems have between 500,000 and 1 million kw. Within 10 years the number of 1 million kw and larger systems may be expected to reach 60, as some of the present 30 go on up to 5 or 6 million kw. Another group of 30 companies have generation between 200,000 and 500,000 kw. In 15 years many of them will have the problems of generation and transmission construction that confront the managements of a few of the largest systems in the country today.

Transmission at 138 kv, or in this general design level, is the backbone for bulk transfer of power in the United States today. Two thirds of the 60 systems with total generation of 500,000 kw or above have transmission in this voltage range. About one fourth of these systems have some or all of their main transmission now operating at 230 kv, and the remainder use 69 kv. About three fourths of the companies with total generation from 200,000 to 500,000 kw also use 138 kv.

The 138-kv lines have been related most frequently to the unit design of the turbine–generator and transformer installation with capacity of 50,000 or 60,000 kw per circuit, and up to 100,000 kw for some conditions. A recent survey of plant design now scheduled indicates that over one half of the total central station capability is in generating units of 150,000 kw and larger and seven units are rated 300,000 kw and above. Manufacturers confidently expect to have turbine–generator designs on a repeat order basis for 500,000 kw.

With the economic size of generating units on a system increasing progressively with increase in the total generation, companies installing 150,000-kw generators now will, for similar conditions and equivalent economy, be adding 300,000-kw generators in another 10 years or 15 years at the most. Transmission circuits at 230 or 345 kv will be needed to balance with the unit sizes in general or average use, and voltages above 400 kv will be needed by many of the larger systems for economical bulk power supply.

RIGHTS-OF-WAY FROM MILLION-KW PLANTS

SECURING THE RIGHTS-OF-WAY for transmission line construction is approaching the condition of being a bottleneck in system expansion. Major decisions on transmission line voltage will, in the future, depend more than ever on the resulting multiplicity of lines for which rights must be procured from plants to load areas.

In a few years, there will be numerous plants larger than the present maximum capacities of about 1 million kw, and systems now having total generation of one half that amount will be installing units in plants that will be developed later to exceed 1 million kw.

Water in vast quantities for cooling and condensing purposes is a basic factor in locating generating plants. This is a problem common to both the conventional thermal plants and the nuclear energy generating plants, which may be equal in the additions of capacity by 1970 or 1975. Plant sites on major rivers and lakes are becoming less readily obtainable and future sites will tend to be at greater distances from load centers than they have been in the past. This condition adds further to the future need for higher voltage transmission.

Transmission lines now being planned for these system developments will still be young in useful life years when power plant capacities and total transmission requirements are doubled and redoubled over present values. When a change is made from present voltage levels the magnitude of the change should be on the basis of this relatively near future condition. In other cases, the design of new lines in an area should contemplate a future change to a higher voltage than is used initially.

PRESENT PROBLEMS OF OVERHEAD TRANSMISSION

LIGHTNING PROTECTION has received major attention in the design of transmission lines during the past 30 years. Research, laboratory and field testing, and many studies went into development of the present fundamental and practical concepts of lightning protection. Today, as we plan lines for operation at higher voltages, some new limitations are encountered in the areas of corona and radio influence. Relationships among the design factors of insulation levels, conductor size and spacing, corona voltage, and radio influence are foremost among the problems for more thorough investigation.

Corona was among the original problems of transmission, and the basic features have been well established through many tests since the earliest days of high voltage transmission. Corona loss tests on 140-kv lines in Michigan were reported in 1919. It was observed that "The line charging current, the current in grounded neutral and the rise in voltage along the line are all greater than calculated from the geometrical capacitance." It was further concluded that "This may be accounted for by an increased capacitance due to increased diameter of conductor caused by corona."

About 30 years later, related problems still confronted designers, as summarized in the 1947 papers outlining the Tidd 500-kv test project.[1-5] It was noted that "Much information is needed on corona and radio influence, and how they are affected by size and type of conductor, spacing and height of ground wire, and atmospheric conditions." Results of the corona investigation at this test installation have been thoroughly analyzed and reported. This work was a monumental contribution to the art and the economics of transmission.

Design of new line projects today, however, continues to raise many pertinent and disturbing questions. More detailed investigations are needed to determine the relative merits of bundled conductors and expanded single conductors. Accurate criteria for the calculation and the limits of radio influence have not as yet been definitely established. Experimental work has indicated that radio influence may be determined by some relationship of the critical voltage and the operating voltage. It is reduced by aging of the energized conductor, but the degree of reduction is not yet known.

The knowledge of lightning performance has been advanced to the point of accurately predicting the results of variations which may be controlled in the design, as applied to lines in the 138- and 230-kv ranges. However, tower height and other physical factors now appear to have a further direct bearing in this consideration for extra-high-voltage design. Experience reports indicate that insulation co-ordination, basic impulse levels, overhead shielding and grounding practices, and other factors need much more investigation.

Developments and test programs may be expected to continue in these fields just as they have in the areas of lightning phenomena as related to present lines. The resultant increased precision in design will be needed in the development of transmission systems to operate at maximum economy for the load conditions of the future.

CABLE RESEARCH PLANNED

CABLE RESEARCH, development, and testing for the voltage range of 345 kv are planned in a program which is now assured by approval of a half million dollar budget for a field testing project. This is to be supported by the electric power industry, as represented by the Association of Edison Illuminating Companies (AEIC) and the Edison Electric Institute (EEI), and will have the co-operation of the manufacturers in furnishing cable and accessories especially developed for this project. It is not believed that cables of the construction now used for 230 kv will be satisfactory for 345 kv and higher due to the inherent losses in the insulation. Testing at 345 kv and above assures benefits also for cables operating at 230 kv and 138 kv.

Direction of the project will be vested in a steering committee representing AEIC and EEI, and it is planned to have test equipment installed and the cable samples ready for initiating of tests in 1959. Testing of the cables and accessories, following developments by the manufacturers, will use the laboratory facilities available and to be added at a test site to be located on a university campus.

Possible needs for higher voltage cables were explored by a task force of the AEIC Cable Engineering Section in a survey about two years ago. They found that 22

companies were considering increases of transmission voltage to the 345-kv range, and that an additional 19 companies expected to raise voltage to 230 kv.

CO-ORDINATED RESEARCH PROGRAM PROPOSED

A SIMILAR SURVEY now probably would show even greater interest as continuing load growth and the mounting difficulties of securing rights-of-way and plant sites bring more attention to the need for greater load and distance capabilities in transmission. There are reports of several field experiments and investigations under way, and numerous additional studies will be made on the problems involved in new designs for 345 kv or higher. These studies will bring benefits also for designs of lines to operate at 230 kv.

The nature of investigations for overhead transmission design differs considerably from development pertaining to steam generators, turbine–generators, and other major items of equipment. It should not be assumed that a broad approach can be made by some one or a few manufacturers even though many of them continue improvement of insulators, structures, conductors, and fittings. Several laboratories and experimental stations may be utilized for various aspects of the broad investigation. However, the results must be fitted into place, along with the improvements in designs of parts, spacings, etc. for a good pattern of over-all design.

Consideration of the problems of extra-high-voltage transmission and the need for answers leads to these conclusions:

1. Many long-range system development decisions must be made within a very few years, and they involve many millions of investment dollars.

2. The needs for additional criteria and design data are urgent. The next decade must bring more and bigger changes in transmission than there have been in the past 25 or 30 years.

3. Research and test information of a basic nature is needed to supplement the operating records that will gradually become available.

4. There is a definite need now for acceleration and integration of the various investigations that will, in time, be made.

5. The potential value of these data justifies engineering and management decisions to develop the program promptly and by concerted effort.

To initiate and continue the program urgently needed now, it is suggested that

1. A task group of steering committee for extra-high-voltage investigation should be given the specific assignment to:

   a. Define the weak and indefinite points in present data and design criteria.

   b. Outline the nature of further tests, experiments and developments that are needed, and

   c. Encourage utility and manufacturing companies and college staffs to undertake individual or specific sections of the over-all program, and arrange for appropriation of funds for test purposes as the needs may be determined.

2. This investigation group should be continued for several years, to represent the broad interests of the industry in reviewing results of the various investigations, to arrange symposia for presentation of the engineering reports, and, in general, to guide the test program.

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Petroleum Plant Model on Display at NYU

A teaching tool at the New York University (NYU) College of Engineering is this 12- by 5- by 5-foot petroleum plant model built by The M. W. Kellogg Company, New York, N.Y. The model is on loan to Dr. Charles J. Marsel, NYU associate professor of chemical engineering (far right), for use in his senior class in organic technology. Eventually it will go to The Pure Oil Company, whose catalytic reforming process unit it represents.

The model will be used later for training plant operators. The others shown examining the model are (from left): Percy A. Maschwitz, process engineer in the Pure Oil refinery technical department; Harold Kershaw, supervisor of plant layout for The M. W. Kellogg Company; and Dr. W. F. Krause, technical manager of Pure Oil's Lemont, Ill., refinery.

A 230-Kv Spar Arm H-Frame Transmission Line

C. C. DODGE
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DURING the past 16 years, the Virginia Electric and Power Company has had in service over 600 circuit miles of 115- and 138-kv wood pole H-frame transmission lines with spar-arm construction. Experience with this construction has been so satisfactory that the new 96-mile 230-kv transmission line between the company's Chesterfield and Possum Point power stations is being built with spar construction for both crossarms and braces. Each end of the line will be tied into the existing 115-kv system through 230/115-kv autotransformers and a tap connection will be made at the Lakeside substation north of Richmond.

A comparison of impulse flashovers of the air gap between conductor and grounding downlead with the flashover of the insulators plus the wood under blowout, led to the decision to use a 19-foot phase spacing with 12 standard 10- by 5¾-inch disks in suspension strings. Flashovers at 4 microseconds with a 1½- by 40-microsecond positive full wave have been used as a basis for comparison. The 4-microsecond flashover of the 12 insulator flashover is co-ordinated with the air-gap flashover. 1,510 kv, which corresponds to the air-gap flashover of the conductor to grounding downlead with an insulator string swing of 28.7 degrees. If the line is installed on level terrain, it requires a wind pressure of 6.25 pounds per square foot on bare conductor to produce this angle of swing.

The angle of insulator string swing for a given wind load will vary considerably in different spans over rough terrain, depending on the amount of vertical loading at each structure. A lower limit on the vertical loading has been set by specifying that a wind pressure of 4 pounds per square foot must not result in an angle of insulator swing greater than the 28.7 degrees at which the insulator flashover is co-ordinated with the air-gap flashover.

Fig. 1 shows the type of bracing used on tangent structures. Hardware items have been selected to permit assembly of the structure with a minimum of field drilling of holes and a minimum of labor. Conductor is 795,000-circular-mil 45/7-stranding ASCR (aluminum cable, steel reinforced) with a maximum design tension of 8,800 pounds under National Electric Code (5th edition) heavy loading. Two ⅜-inch 7-strand high-strength steel overhead static wires are used.

Structures with 70-foot poles on level ground result in a normal span of 700 feet, or 7.5 structures per mile, with a minimum ground clearance of 29 feet. The actual average number of structures is 8.3 per mile because of extra clearances required at crossings and a rather large proportion of angles in the line.

Two full-size structures were built and loaded transversely to the point of failure in order to check the hardware fittings and the effect of uplift. Additional uplift tests were made on pole stubs set under different soil conditions and with crushed rock backfill. One structure was tested with vertical loads equivalent to ½-inch of ice on a 1,000-foot average span. A transverse force of 14,725 pounds caused a cross-brace bolt on the upper end of the brace to shear. The second structure was tested with vertical loads equivalent to bare conductor on a 1,000-foot average span. A transverse force of 15,525 pounds caused the upper end of a cross-brace to split. Both of these transverse forces represent over 4½ times maximum design loading for 1,000-foot average spans. The uplift tests demonstrated the value of crushed rock for backfilling pole holes. This method has been used on average spans over 700 feet.

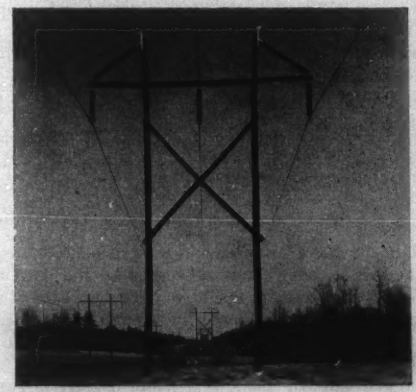

Fig. 1. All spar construction tangent structure.

Construction started February 1, 1956, and 51 miles of line were completed in four months. Maximum use is made of mechanized equipment. Pole holes are dug mechanically and structures are erected with a crawler crane after assembly on the ground. A mobile aerial tower is used for applying armor rods and clipping in conductor. Mobile radio units on automotive equipment and portable pack units are of invaluable assistance in providing necessary communication for construction activities.

Digest of paper 57-154, recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meetings, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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An Ignitron Contactor for Direct Press Drives

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The use of an ignitron contactor panel for direct press drives for large draw presses reduces the impact of shock loading to the motor, gears, keyways, and other mechanical parts of the drive. Maintenance requirements are thereby reduced. These improvements are obtained at a relatively minor additional cost of the initial installation.

THE USE OF DIRECT DRIVES for large draw presses in industry was originally brought about by the continued demand for higher rates of production as well as higher capacities in the presses themselves. The usual method of allowing the main drive motor to run continuously while the press is started and stopped by the operator controlling a clutch has become extremely costly because of production interruptions for clutch maintenance.

By gearing the drive motor directly to the crank of the press, and starting and stopping the motor for each operating cycle, the problem of clutch maintenance is eliminated. However, with the increase in motor horsepower the problem of maintenance has not been eliminated, but merely transferred from the clutch to the motor and its controller.

Since the motor is started and stopped for each stroke of the press, a large contactor must close and open the circuit for each cycle of operation. The high rate of operation causes rapid erosion of the contact tips, and contributes to relatively short mechanical life of the contactor. Shock loading of the gear train each time the motor is connected to the line causes damage to gears, shafts, and keyways, eventually requiring complete overhaul of the press.

Additional contributions to contactor distress and motor maintenance are produced during die set-up procedures in which the operator may repeatedly inch the press through most of a complete press cycle. Under these circumstances arcing is present at the contactor tips. The motor may be subjected to very severe transients which produce additional thermal and mechanical stresses within rotor bars, rings, and phase windings. Inrush currents to the motor may be sufficient to produce welding of the main contactor, which shuts down the press until maintenance crews can adjust or replace the contacts.

Essentially full text of paper 57-191, recommended by the Committee on Industrial Control and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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The ignitron contactor for direct press drives is a new approach to relieving these difficulties. By connecting a pair of ignitrons back to back in each of the three phases, a contactor is obtained which is capable of closing the circuit for each operating cycle and still render long, trouble-free service.

Use of ignitrons as contactors permits utilization of their useful characteristic of reducing output voltage by retarding their firing angle, commonly known as phase back. By incorporating phase-back action with slope control, the motor terminal voltage is permitted to build up to nominal value in a few cycles. Thus a cushioned start of the motor is obtained with negligible increase in starting time.

The cushioning action of the phase-back circuit has several useful functions. It minimizes the effect of the d-c transient in the motor, thereby reducing the component of braking torque caused by this transient. Slack in the gear train is taken up softly instead of with a sharp hammer blow as would occur when the motor is started at full line voltage. Magnetic forces within the motor are reduced at the moment of voltage application, lessening stress to the rotor conductors and reducing working of the phase windings to the point where motor life is multiplied. Smaller increments of movement are possible when inching the press because the small relays used to control the ignition circuits are much faster in response than the large mechanical contactors normally used to control the motor current directly. This makes the press respond more quickly for inching operations.

CONTROLLER OPERATION

A SIMPLIFIED DIAGRAM of the controller is shown in Fig. 1. Nonessential features such as transformer primaries, safety circuits, etc., are omitted. Note that each phase employs two ignitrons connected back to back. Associated with each ignitron is a thyratron which is used to control the firing of the ignitor. Operation is obtained by closing the contacts of firing relay *FR* which is controlled by the operator.

Each of the thyratrons in the lower part of Fig. 1 controls an ignitor connected through relay contacts *FR*. The thyratrons function as diodes. Ignition is obtained by closing the contacts *FR*, provided there is a path for the current to flow through one or more of the thyratrons in the upper part of Fig. 1.

The thyratrons in the upper part of Fig. 1 control all the currents flowing to the motor, while those below control the current from the motor. Because any current flowing at all must simultaneously flow both to and from the

motor, at least two thyratrons or ignitrons must be conducting simultaneously.

By the same token, control of the grids of the upper three thyratrons controls the current to the motor, and remaining three thyratrons and ignitrons which conduct the current from the motor are slaves and can only follow. The manner in which the upper three thyratrons control the current to the motor is as follows:

In Fig. 1, consider the condition with relay *FR* deenergized. Capacitor *3C* is by-passed through *2RES*, which is of low ohmic value and limits the rate of discharging *3C* later in the sequence. The grid, therefore, is at the potential generated by the *Y1-Y2* winding of transformer *1GT (2GT* and *3GT)*. The transformer primaries are connected to the supply line to give grid voltages which lag respective plate voltages by 120 degrees. (*1RES* is the standard grid resistor limiting positive grid current and *1C* is used to filter off spurious noise signals from the grid).

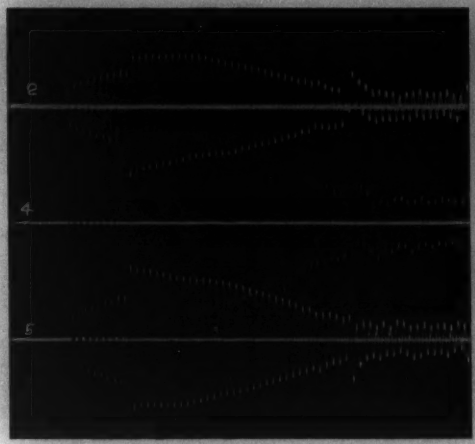


Fig. 2. Oscillograph trace of accelerating current.

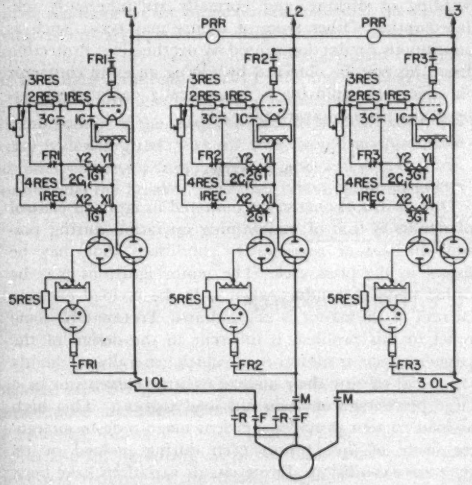


Fig. 1. Simplified diagram of controller.

At the instant *FR* is energized, the plate circuit of the thyratron is completed and the ignitors are caused to fire late by 120 degrees. At this same time, an *RC* circuit is introduced by the opening of normally closed contact *FR*, which removes the discharge circuit from *3C*, which then takes on a positive charge from transformer winding *X1-X2* through rectifier *1REC* and resistors *4RES* and *3RES*. The latter is adjustable to control the rate of charging.

As capacitor *3C* takes on a positive charge, the grid voltage, now made up of the sum of this charge and transformer voltage *Y1-Y2*, increases in the positive direction. As it does so, the thyratrons and the ignitors are fired earlier in the cycle until positive capacitor voltage finally exceeds peak transformer *Y1-Y2* negative voltage. The entire system is then firing full on. This sequence takes place in a few cycles and is referred to as slope control.

It is interesting to note that the control by phase-back network of three of the ignitrons, while the remaining three are phased full on, gives full control of the alternating current delivered to the motor. A way of explaining this might be that the currents flowing to the motor must equal the currents flowing away from the motor. Since the three upper tubes control the currents flowing to the

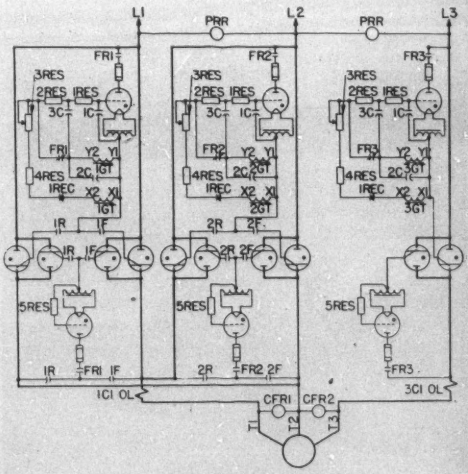


Fig. 3. Reversing with ignitrons.

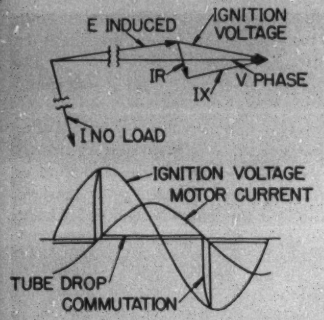


Fig. 4. Ignition voltage diagram.

motor, the remaining three tubes are slaves and must follow.

In Fig. 2, the oscillograph trace shows the initial current, the slope for a few cycles, and then the application of full current to accelerate the motor to full speed. It will be noted that there is a step change in the current values as the full current condition is reached. This occurs because the combinations of a d-c bias and an a-c grid control voltage gives a range of only 90 degrees. As the d-c bias in the positive direction approaches the peak value of the negative a-c wave, control of the phase back is lost. This step change has not been found detrimental to the operation of the control scheme, but if desired can be eliminated with an alternate firing arrangement.

REVERSING WITH IGNITRONS

In a normal press control application of this nature, reversing of the motor is used only for die set-up and emergency conditions. Hence, a mechanically operated magnetic contactor is satisfactory for this purpose. Since it must be employed in series with the main ignitron contactor, it may also be used as a safety contactor to open the motor circuit in the event of ignitron failure. Reversing with ignitrons is also possible as shown in Fig. 3. It is interesting to note that no additional firing circuits are required for this connection. The six existing circuits are switched with small contactors to the proper pairs of ignitrons to obtain the desired direction of rotation. Reversing is accomplished by interchange only of lines *L1* and *L2*. This eliminates any transfer switching requirements for the circuitry of *L3* so that a single pair of ignitrons will suffice for control of this line. Observe that reversing with ignitrons is obtained with the basic additions of two pairs of ignitrons and the small contactors necessary for switching control to the proper ignitron pairs.

Fig. 5. Main contactor panel with firing circuits.

For contactor sequences employing magnetically operated mechanical contactors, safety precautions demand that the forward and reverse contactors be placed in series with the main contactor so that the motor circuit can be opened even if welding or sticking of the main contacts is encountered. A controller using ignitrons for reversing does not normally require mechanical contactors in series for opening the circuit. The ignitrons are not subject to welding or sticking, and normally are inherently self-interrupting. Other types of failure may occur, such as continuous conduction caused by overheating. Protection from this may be obtained by adding an extra contactor in series or employing a magnetically operated circuit breaker with a shunt-tripping coil.

PRECAUTIONS

One of the problems encountered in ignitron control of motors is that of maintaining operation during possible no-load or regenerative conditions that may be found in the press cycle. The motor ignitrons may be called upon to conduct when only the no-load exciting current of the motor is being drawn. Fortunately, some relief to this problem is inherent in the design of the large horsepower motors used, which generally are highly saturated, causing their no-load exciting currents to be a large percentage of their full load currents. This high no-load current provides sufficient magnitude to guarantee firing of the ignitors even during no-load or regenerative conditions. Firing circuit variations have been evolved which use thyratron grid hold-off to prevent conduction through the ignitors when motor currents are obtained below the satisfactory level for firing of the ignitrons. These circuits have not been required to date because the motor sizes so far encountered have not reached this lower limit.

While minimum ignitor current is important, a certain voltage is also required to insure ignition. This voltage available to the ignitor circuit is a function of the countervoltage developed by the motor. During starting and acceleration, there is no problem because the countervoltage is reduced in magnitude by the large impedance drops in the motor. Fortunately, direct-drive press motors are usually applied at 440 volts so that sufficient difference voltage still exists between the line and motor countervoltage during running conditions to permit this type of control to operate.

When examining the firing voltage in back-to-back operation, the angle between this voltage and the current becomes important. Reference to Fig. 4 will show that this angle is governed essentially by the impedance angle of the motor. For a given motor this angle remains relatively constant. The voltage available to fire is the difference between the line voltage and the countervoltage of the motor on a vector basis for each phase. In back-to-back operation only one tube in the pair can conduct at a time. As one tube ceases to fire, the impedance drop voltage appears almost instantly to fire the ignitor in the other tube in the pair. This commutation takes place as this voltage has progressed well up towards the maximum value on its sinusoidal curve. It is this set of conditions which makes the load fired ignitor feasible for this application. Motors normally applied for direct press drives have been found to have impedance angles and impedance drops of proper magnitudes for success.

Several other precautions must be observed in the application of this controller. Phase reversal relays are required, as shown in Figs. 1 and 3, to guarantee proper phase sequence on the input terminals so that the phase-back circuits are properly oriented. Proper connection to insure correct direction of motor rotation must be done at the motor terminals. Relays *CFR1* and *CFR2* (Fig. 3) across the motor terminals are so connected as to trip the circuit breaker if the tubes continue to fire after the firing relay is de-energized. Such an event would maintain one or both of these relays energized, and a timer, in turn, would trip the breaker. Overload relays of the magnetic type are employed in the motor circuit to give an additional measure of protection in the event that large d-c components appear in the motor circuit because of the failure of any one of the ignitrons to fire over several consecutive cycles.

Where motor horsepower is too low for the ignitor firing circuits, it is possible to employ thyratrons directly in the lines to the motor featuring the same method of control except without the problem of firing the ignitors.

An incidental benefit is the great reduction in noise level of controller operation when ignitrons are used.

CONCLUSIONS

An ignitron contactor panel complete with firing circuits is shown in Fig. 5. The cushioning action of the phase-back and slope control features reduces the impact of shock loading to the motor, gears, keyways, and other mechanical parts of the drive, which in turn reduce maintenance requirements. The response characteristic is greatly improved over that obtained with electrically operated mechanical contactors.

Because of the absence of large moving parts, and the use of static components, this controller requires little maintenance and offers long, trouble-free service. Drastic reductions in down time and attending production losses are obtained.

These important improvements are obtained at the relatively minor additional cost of the initial installation and of providing water for cooling the ignitrons.

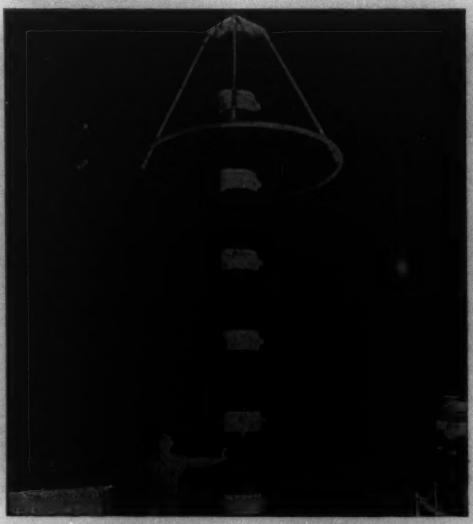
Self-Supporting Lightning Arresters

A new line of self-supporting lightning arresters (called type *SVS*) in ratings from 48 to 336 kv has been introduced by Westinghouse Electric Corporation of Pittsburgh, Penna. Designed primarily for large substations and for mounting on power transformers, the new arresters require less mounting height and no bracing or supporting structures.

The new arresters are built up of self-contained units which assemble into arrester columns shorter in height than previous designs. The reduction in height is accomplished by arranging three stacks of elements in a single porcelain housing. Although the stacks are physically in parallel, they are electrically in series. Arresters of higher ratings can now be assembled using fewer units at lower installation costs because of the compact design.

The same time-proven "Autovalve" blocks, solder-sealed porcelain-enclosed gaps, ceramic magnets in the gaps, and pressure relief devices used in the *SV* line of arresters, are retained in the new design.

Installation is simplified since the single-column arresters require no mechanical bracing even up to the highest voltage ratings.



Microwave Relaying and System Design

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THE POWER SYSTEM planning engineer bases major decisions concerning service continuity on expected system performance during faults and other abnormal conditions. Frequently the protective relay system places additional limitations on system performance. (An illustration of this is a system which is unstable with 30-cycle relaying, but may be stable with 1-cycle relaying.) One of the continuing objectives of the relay engineer is to minimize or completely remove these relaying limitations to system performance.

Multiterminal lines, in particular, frequently have relaying limitations which limit the system capability. This is becoming a costly restriction as more utilities feel the economic need for superimposing distribution requirements on main-line transmission circuits. Relaying limtations can also seriously restrict the system's performance when existing facilities must be integrated into new transmission requirements.

An analysis of these limitations frequently reveals that they are caused by compromises in the relay system, inasmuch as the relays at each terminal cannot completely determine the necessity for tripping within the time permitted by other system requirements. Further analysis will indicate that by comparing the electrical conditions at two or more terminals of the protected line, it will be possible to determine the necessity for tripping.

Thus, one can say that the limitation is one of communications rather than of relaying. Communication facilities such as leased-wire and power-line carrier lack complete reliability and security. Leased wire has a further drawback that fundamental responsibilities are outside the jurisdiction of the power company. Power-line carrier relaying functions depend upon the condition of the power system. In addition, the number of channels which can be practically applied to a line or a system are limited.

Ultimately microwave communications will have none of these defects. Furthermore, since no high-voltage power system components are used, station design can be simpler, and a minimum of circuit outages is required for construction and maintenance. Tests covering a 2-year period and reported in another paper (Field Tests of Microwave Relaying Equipment by E. W. Downer, AIEE paper 57-209) demonstrate that presently available microwave equipment adequately meets the requirements of protective relaying communication channels. Thus, microwave for relaying has been adopted as a working tool.

Microwave relaying systems are now in service or under construction on 25 transmission line terminals at five locations on the Cleveland Electric Illuminating Company system. The initial installation is providing transfer trip for a 100-mva 132/66-kv autotransformer which does not have a high-voltage circuit breaker. The associated 132-kv line, as well as other 2- and 3-terminal lines, is protected with microwave relaying using a "zone comparison" method. With this scheme, the response of directional fault-detecting relays, calibrated to overreach the far terminal by only a nominal amount, are compared over the microwave channels.[1] The received microwave signal is confirmed by a local fault detector before tripping is permitted. This is in contrast to the blocking scheme used in most power line carrier directional comparison systems.

The other microwave relaying installations require additional functions, such as transient blocking, out-of-step blocking, and open-breaker signal transmission in order to provide the necessary system performance. The open-breaker signal transmission is required by the "zone comparison" method when applied to lines with three or more terminals. Separate signal channels are used for phase and ground relaying. The straightforward approach used in this system permits engineering these functions into any desired combination. The use of standard components further aids the integration of microwave into test and operating personnel practices.

The significance of this approach to a fully competent relay system has already been appreciated in the design of this system. In one of the initial installations, the replacement of two 132-kv circuit breakers was forestalled by relaying a 132-kv-line section as a unit with two 132/66-kv transformers and associated 66-kv cables. In other installations, major investments for 132-kv circuit breakers have been eliminated by the further application of 3-terminal lines. Also, the integration of other facilities has been carried out with the postponement of new breakers for 3 to 15 years.

Safeguards have been incorporated into these original microwave relaying installations to assure a working system even if errors in evaluating the original two years' experience should develop. However, fully annunciated installations will provide a rapid accumulation of field data on the working system.

The acceptance of microwave communications as a working tool has provided solutions to many problems of transmission relaying and system design.

REFERENCE

1. Protective Relaying Over Microwave Channels, H. W. Lensner. AIEE *Transactions*, vol. 71, pt. 3, 1952, pp. 240-45.

Digest of paper 57-13, recommended by the AIEE Committees on Relays and Power Systems and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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The Calculation of Can Losses in Canned Motors

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CANNED MOTORS are those which are distinguished by having a thin cylindrical metal diaphragm or "can" in the inner bore of the stator, thus serving to isolate the stator windings from the fluid which completely fills the rotor cavity. These motors are generally of the squirrel-cage induction type and their rotors are also normally canned in order to prevent corrosion of the bars, end rings, and punchings from the fluid in the air gap.

The rotating magnetic field produced by the stator must, therefore, pass through a stationary can on the stator and a rotating can on the rotor. It is apparent that a high eddy-current loss will be induced in the stator can.

A first approximation to the magnitude of this loss may be obtained by making the assumption that there is zero end-ring resistance in that portion of the stator

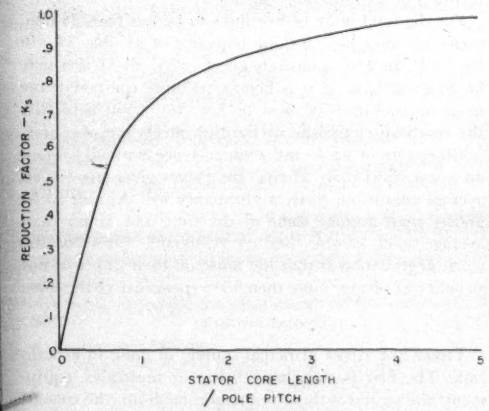

Fig. 1. Reduction factor for stator can loss.

can which extends beyond the stator core. The following equation may readily be derived:

$$W = \frac{15.5\ B^2\ n^2\ D^3\ l\ t\ x\ 10^{-16}}{\varrho} \text{ watts} \qquad (1)$$

The distribution of currents in the stator can when the actual end-ring resistance is introduced may be obtained by a method directly analogous to 2-dimensional flux plotting of magnetic fields. This method leads to the reduction factor shown in Fig. 1. Thus: stator can loss $= K_s\ W$ watts.

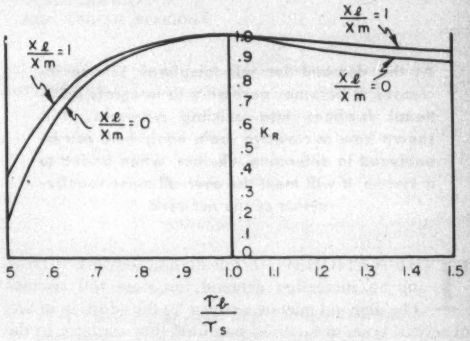

Fig. 2. Reduction factor for rotor can loss.

The stator slot openings produce a ripple in the no-load flux wave which stays stationary in space. This ripple cuts the rotor can at full rotational speed and thereby induces an additional eddy-current loss.

The familiar Carter's coefficient for the stator slots provides a measure of the magnitude of this flux ripple. However, the ripple is somewhat reduced by induced currents in the squirrel-cage rotor bars and the loss in the rotor can is correspondingly reduced. This reduction factor is shown in Fig. 2. A further correction to the loss must be made for the fact that the wave shape of the ripple departs a great deal from sinusoidal. An empirical equation for this loss is:

$$\text{Rotor can loss} = 1.3\left(\frac{b_t}{b_s}\right)\left(K_{cs} - 1\right)^2\left(K_r\right)\left(W\right) \text{ watts} \qquad (2)$$

The stator and rotor can losses should be added to the total no-load losses established by conventional methods.

NOMENCLATURE

B = Peak flux density in air gap in lines per square inch
D = Diameter at gap in inches
K_{cs} = Carter's coefficient for the stator slots
b_t = Width of stator tooth at air gap in inches
b_s = Width of stator slot at air gap in inches
l = Length of core in inches
n = Speed of rotating field in revolutions per second
t = Thickness of can in inches
τ_b = Rotor bar pitch in inches
τ_s = Stator slot pitch in inches
ϱ = Resistivity of can in ohm-inches
X_ℓ = Leakage reactance of rotor bars
X_m = Magnetizing reactance of rotor bars

Digest of paper 57-134, recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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Noise Considerations on Toll Telephone Microwave Radio Systems

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As the demand for toll telephone service increases, it becomes necessary to integrate additional facilities into existing networks. It is shown how microwave radio equipment can be analyzed to determine whether, when added to a system, it will meet the over-all noise requirements of the network.

THE NATION-WIDE toll dialing network is creating an increasing demand for more toll circuits. The demand may be satisfied by the addition of any of several types of facilities provided they conform to the over-all requirements of the network.

It is the purpose of this article to show how microwave radio equipment can be analyzed to determine if, when integrated into a system, it will meet the over-all noise requirements of the nation-wide network. Radio system noise is broken down into its basic components, and minimum values are suggested for each component. Finally, the manner in which the components combine to produce the measured noise in a channel is shown by an example.

In instances where the breach in language between the radio engineer and the telephone engineer is considered a deterrent to common understanding, attempts have been made to bridge the difference.

NOISE OBJECTIVES

MOST RADIO MANUFACTURERS specify noise performance in signal-to-noise ratio terms that are easily related to test-tone-to-noise measurements. However, in multichannel telephone communications systems, the ratio of noise to speech in individual channels is somewhat tenuous.

In speech transmission, it is customary to measure noise performance by comparing the interfering effect of channel noise to the interfering effect of an arbitrary reference noise. This is done with a special meter consisting of a volume indicator and weighting network that takes into account the frequency and transient responses of the transmission line, the telephone handset, and the human ear. The unit of interfering effect is the dba (decibel adjusted).[1]

All noise values given here are in dba, as measured with the Western Electric Company type *2B* noise measuring set or equivalent, using "F1A" weighting at the 0 db transmission level point. "Transmission level" is measured in db referred to a common point in the system or circuit. The reference point is usually the transmitting toll switchboard. The transmission level at the reference point is 0 db.[2]

Current telephone practice is to engineer toll facilities so that they will meet the requirements for the nation-wide toll dialing network. A commonly stated objective for an end-to-end connection through the network is 38 dba. For example, this objective might be for a connection between New York, N.Y., and San Francisco, Calif., built up of five separate links by automatic switching equipment along the way. Although seven links on one connection are possible under the toll switching plan, the great majority of calls will be completed via five links or less. A link may be composed of wire, cable, or radio facilities or combinations of these.

For the total noise of five links to be less than 38 dba, each link must have a noise objective of 31 dba (38—10 log 5). If the link is entirely one facility, all 31 dba may be assigned to it. If it is heterogeneously composed, the noise on each facility must be kept low enough so that the resultant composite of the link meets the objective.

Objectives of noise and cross talk are normally stated on a statistical basis. Hence, the values given are for an average condition. Noise performance will degrade to be poorer than average some of the time and better than average some of the time. A reasonable limit for the worst degradation is that the noise on each link will not go below 51 dba for more than 0.1% (per cent) of the time.

NOISE SOURCES

THERE ARE THREE principal sources of noise in a radio link. The first is the channelizing or multiplex equipment; the second is the transmission medium (the coaxial transmission line, wave guide, antenna systems, and the transmission path through the atmosphere); and the third is the radio equipment. This article is concerned primarily with radio equipment noise. Channelizing equipment noise is fairly familiar to most telephone engineers and can be measured easily by connecting the two channelizing terminals on a back-to-back basis. The channelizing equipment should be designed so that it does not contribute appreciably to the over-all noise in a radio link. A reasonable value to expect from this source is 20 to 23 dba.

Noise in the transmission medium is generated by echoes or multiple paths of transmission so that the radio equipment receives two or more signals which may vary in phase. Noise originating in the transmission path

Full text of paper 57-59, presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Recommended for publication by the AIEE Committee on Radio Communication Systems.

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when minimized by proper system engineering should not be a cause of poor performance for short or medium length systems. In FM radio links above 500 mc, the problem of "man made" and atmospheric disturbances which produce noise in the radio receiver may be ignored.[3, 4]

RADIO EQUIPMENT NOISE

THE NOISE GENERATED by the radio equipment can be divided into three categories that are relatively easily measured or calculated. These divisions are the transmitter noise, receiver noise, and intermodulation noise. It is important to note that interrelationships exist between them.

Transmitter. Transmitter noise is primarily a function of the modulator or klystron tube used in a system and is caused by random current fluctuations in this stage. It can be measured by connecting a radio transmitter and receiver back-to-back through a line having losses, and measuring the noise in a 3.5-kc slot in the baseband output under conditions of no load on the radio equipment. The value of transmitter noise is indicated when the measured noise does not decrease with further increases in received r-f signal strength. This is shown graphically in Fig. 1 as the top "leveling off" point on the curve of noise vs received signal strength.

Transmitter noise is not the result of intermodulation, as it is present even when no signal is applied to the transmitter. The effect of transmitter noise can be minimized by increasing the modulation level, thereby producing more signal in the receiver, so that the ratio of transmitter noise to transmitted intelligence will be reduced. However, increasing the modulation levels will also increase the intermodulation noise. Thus, a compromise between the noise sources must be achieved.

Receiver. Noise generated in the radio receiver is sometimes referred to as thermal noise. A theoretically perfect receiver would have an input noise power given by

$$\text{Noise power} = KTB$$

where

K = Boltzmann's constant
T = Temperature, degrees Kelvin
B = Bandwidth

Inasmuch as K is a fixed quantity and T is relatively constant (usually assumed fixed at 300 degrees Kelvin), the equation shows that the noise generated in a theoretically perfect receiver is determined by the receiver bandwidth term B. This is bandwidth ahead of the detector and includes the over-all r-f and i-f bandwidths.

All microwave receivers add some noise to that theoretically present at the receiver input. The additional noise is generated primarily in the r-f amplifier (if one is used), in the r-f mixer crystal, and the first i-f stage of amplification. The ratio of this noise to theoretical minimum input noise determines the noise figure F_r of the receiver. It is usually expressed in decibels. Thus, a noise figure of 9 (db) means that the receiver is 8 times noisier than the theoretical minimum possible with that bandwidth.

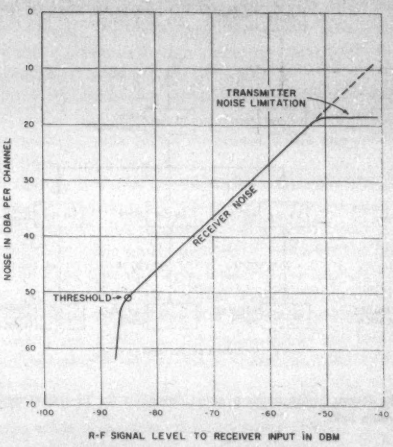

Fig. 1. Typical plot of system noise as a function of receiver input signal.

The theoretical minimum noise plus the noise figure of the receiver determine the threshold point of the receiver. The threshold of an FM receiver is the point at which the received signal power is just adequate to overcome the effect of noise power peaks and thereby capture the receiver.

The received signal power required for this capture of the FM receiver is generally accepted to be 10 db above the total receiver noise power ($KTB + F_r$) where KTB is the theoretical noise power for a given bandwidth and F_r is the receiver noise figure expressed in db. For example, the noise power in a 5-mc band at 300 degrees Kelvin is –107 dbm. If a receiver has a noise figure of 12 db the total receiver noise power is then –95 dbm and the receiver threshold is –85 dbm. In this particular receiver, when the signal level falls below –85 dbm the channel noise becomes very large; and when the received signal strength increases above –85 dbm, the channel noise decreases linearly db for db until some limiting condition is reached. The limiting condition usually is caused by either intermodulation or transmitter noise.

It is always desirable to maintain as large a margin as possible between the received signal and the threshold point. During fades, the channel noise increases rapidly as threshold is approached. Below threshold, the circuit becomes useless.

The lower the threshold noise, the greater the percentage of time the channel noise will be acceptable. The probability of a deep fade is smaller than that of a shallow one. The threshold point should be at least as low as that r-f signal level which is exceeded 99.9% of the time. The per-channel noise at threshold will then be equal to the noise which cannot be exceeded for more than 0.1% of the time. On many radio paths, the limiting factors in determining the permissible locations of the terminal or

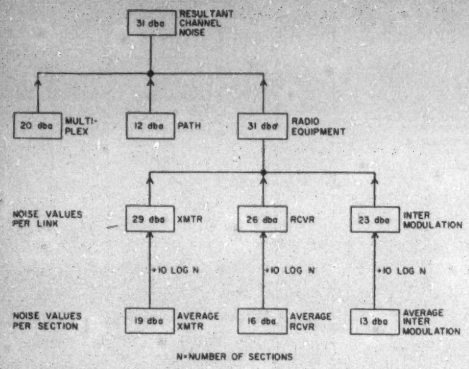

Fig. 2. Channel noise under average conditions for 10-section medium-haul radio link.

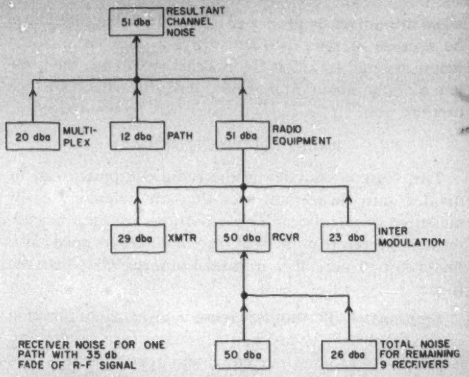

Fig. 3. Channel noise under "0.1% of the time" conditions for 10-section medium-haul radio link.

repeater equipment are the amount of average signal and the fade margin required.

Reduction in threshold level can be accomplished by making the bandwidth as narrow as possible and by reducing the receiver noise figure. The receiver noise figure is minimized by careful design of the receiver "front end." The receiver bandwidth should be just wide enough to pass the intelligence with a minimum of intermodulation distortion.

In selecting microwave radio paths, the value of fades anticipated and the percentage of the time in which they occur can be worked out on a theoretical basis.[5,6] Using such calculations, the transmission engineer tries to establish paths over which predicted depth and frequency of fades will fall within established system objectives. A system engineered to meet the usual link objective would have a predicted r-f signal input above the value corresponding to 51 dba for all but 0.1% of the time, or about 8 hours per year.

Systems designed in this manner usually are found to have very low receiver noise under average propagation conditions. Under these average conditions transmitter and intermodulation noises are the primary ones, while the receiver noise is important only during fades.

Above threshold, receiver noise varies inversely with r-f signal level on a db-for-db basis. In a system with both transmitter and receiver noise sources, the minimum noise is controlled by the transmitter noise. The system noise as a function of receiver r-f signal level can be plotted conveniently to form a curve such as shown in Fig. 1.

Intermodulation. The third source of noise in the radio equipment is intermodulation resulting from amplitude or phase distortion in the transmitter and receiver. Intermodulation distortion occurs when the system is loaded, and increases when the load increases. Inasmuch as it is uneconomical to design for complete freedom from intermodulation, good engineering practice is to allow the intermodulation distortion to reach some small but finite value a small percentage of the time.

On a system handling a load consisting of many speech channels, studies have shown that the complex multichannel speech signal is random in nature and can be simulated quite accurately by random noise. Because of the random nature of the load, the intermodulation products on a large channel system (48 channels or more) are also random, and result in a random type noise on all of the channels.

Methods of measurement of intermodulation noise involve a determination of the level of the multichannel speech load to be expected. General practice has been to determine this load in terms of the peak loads which are exceeded during 1% of the busy hour.[7,8] The random-noise equivalent of the speech load is then used to load all of the base band except for a slot the width of a channel, usually 3.5 kc. The amount of noise appearing in this 3.5-kc slot at the receiver output is then a measure of intermodulation noise which will be exceeded for only 1% of the busy hour.

Increasing the modulation level to offset transmitter and receiver noise is desirable, but results in increasing system load and intermodulation distortion noise. A suitable compromise is to make the intermodulation noise (which is exceeded 1% of the busy hour) equal to the transmitter noise. If this balance of noise contributions is made, the per-channel noise under normal propagation conditions (when receiver noise is negligible) will increase less than 1 db for 90% of the busy hour and less than 3 db for 99% of the busy hour as the result of intermodulation.

Actual laboratory tests made to determine the proper modulation levels involve setting up a system with a large r-f signal input to the receiver to insure that receiver noise is negligibly small. Without loading, the noise power in the 3.5-kc slot is measured. The noise generator

loading the base band (except for the 3.5-kc slot) is then turned on and the noise loading power adjusted until the noise in the 3.5-kc slot has increased 3 db above the unloaded value. The proper transmission level to the transmitter base band input can then readily be determined in terms of the number of channels and the power of the noise signal which produces the 3-db increase.

BALANCING NOISE CONTRIBUTIONS

IT IS EVIDENT that considerable interdependence exists among the various noise sources and the factors of bandwidth and modulation level. For optimum system design these factors must be balanced so that the noise requirements under average conditions and under "0.1% of the time" conditions are satisfied.

Inasmuch as the receiver noise figure is always minimized, the principal factor determining the threshold point of the receiver is the bandwidth. Lowering the threshold point by reducing the bandwidth will cause increased intermodulation noise. Likewise, if the bandwidth is kept fixed, increasing the modulating level will decrease the effect of transmitter and receiver noises for any r-f input above threshold, and cause increased intermodulation noise.

The proper balance between bandwidth, modulation level, and intermodulation noise is obtained when (1) the threshold is kept as low as possible; (2) the per-channel noises at threshold equal the "0.1% of the time" requirement (51 dba); and (3) the "1% of the busy hour" intermodulation noise equals the transmitter noise.

The previously stated objectives for noise are applicable on a link basis. When establishing the objectives for individual sections, it is necessary to know the number of sections to be expected in the link and also the way in which noise products combine. For a transcontinental link such as the Bell System's *TD-2* microwave system, the section noise objectives must necessarily be more stringent than for a short link.

The manner in which different noise sources combine to form a resultant product is dependent upon the nature of the noise. Pure random noise such as receiver and transmitter noise will always add to produce random noise, and the combinations add as power functions. This is also true of intermodulation when the second-order products are predominant. In multiplex systems where the baseband is contained in a single octave, second-order products cannot normally produce interference, but higher-order products can. In these systems, third-order intermodulation distortion predominates. The third-order per-section intermodulation products add in phase and must be added on a voltage rather than on a power basis.

Fig. 2 illustrates the way that the noise sources in a 10-section radio link will combine under average conditions for a radio system where second-order intermodulation products predominate. The factor of 10 times the logarithm of the number of sections is added to the average section noise for each noise source to give the resultant link noise from each source. The transmitter, receiver, and intermodulation noise factors are then added to give the noise attributable to the radio equipment. Finally, the radio-equipment noise, channelizing equipment noise, and path noise are combined to give the resultant channel noise per link.

Fig. 3 illustrates the same system under an assumed 0.1% of the time condition of a 35-db fade in one path. The resultant noise under these conditions has increased by 30 db.

From Fig. 2, it may be noted that under the 1% of the busy-hour conditions the value for intermodulation will change from 23 dba to about 29 dba. This causes a 2-db degradation of the resultant channel noise for the link.

If the same type of charts, knowing the number of sections, and starting with the link objectives are used, it is relatively easy to establish the values of noise required for each block. Radio and multiplex equipment manufacturers can usually supply specifications on noise contributions by their equipment. Using this data, the requirements for average receiver noise can be calculated and integrated into the radio path requirements.

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8. A Speech Volume Survey on Telephone Message Circuits, V. Subrizi. *Bell Laboratories Record*. New York, N. Y., Aug. 1953.

Reactor Installation

Induction heating coils are installed on the bottom of the main core vessel of the Organic Moderated Reactor Experiment (OMRE), an experimental nuclear power reactor being built by Atomics International, a division of North American Aviation, Inc., at the Atomic Energy Commission's National Reactor Testing Station at Arco, Idaho. The project is part of the AEC's program to develop economical power from nuclear energy. Construction of the OMRE facility is expected to be completed this year.

INSTITUTE ACTIVITIES

Full Program Planned for Great Lakes District Meeting, April 15-17

THE AIEE Great Lakes District Meeting for 1957 will be held April 15-17 at the Hotel Fort Des Moines in Des Moines, Iowa. The meeting will embrace a full program consisting of technical sessions, student sessions, inspection trips, social functions, and special activities for the ladies.

Hotel Reservations

Arrangements have been made for members and guests at the Hotel Fort Des Moines. Reservations should be mailed to Charles Lex, Reservations Chairman, General Electric Company, 505 West Fifth, Des Moines, Iowa. Hotel prices are as follows at the Fort Des Moines: Single, $5.50–$12.00; Double, $9.50–$14.00; Twin, $12.00.

Registration

Registration desks will be located on the mezzanine floor of the hotel. Registering facilities will be available Sunday, April 14, from 6:00 to 9:00 p.m., Monday and Tuesday, April 15 and 16, from 8:30 a.m. to 2:00 p.m. All fees will be collected at the registration desks.

Ladies Program

Sunday, April 14. Coffee in late afternoon.

Monday, April 15. Morning coffee. 2:00 p.m., tour of Meredith Publishing Company (Better Homes and Gardens, etc.).

Tuesday, April 16. 12:00 Noon. Luncheon at Wakonda Club, "Easter Bonnet Revue" Bridge and Prizes.

Wednesday, April 17. 9:00 a.m. Tour of Salisbury House and Art Center. Salisbury House is a unique Gothic-Tudor mansion copying parts of historic homes in England. Fireplaces, wood paneling, and carvings have been imported from these old homes. The Des Moines Art Center is one of the distinguished art centers in the country from both the architectural and gallery standpoints.

Inspection Trips

Tickets for inspection trips will be available at the registration desks. Transportation will be provided as a part of each tour. Transportation costs will be $1 for tours in Des Moines and $2 for those out of town.

Monday, April 15, 2:00 p.m. Iowa Power and Light Co. "System Operations Center." This center controls all electric transmission and generation activities. It is a nerve center complete with a lighted system diagram, telemetering equipment, and teletype, radio, carrier-current, private line and telephone communication. Adjoining the center is a statistics group which processes load, generation, and foreign interchange billing data. No transportation charge.

Tuesday, April 16, 8:30 a.m. Maytag Manufacturing Company at Newton. Maytag produces the famous Maytag Automatic washers and dryers. The plant area comprises 73 acres and includes departments for pressing, die-casting, permanent mold, rubber and plastics, electroplating, electro static spray painting, porcelainizing, and testing. Automation has been and is a byword with Maytag. One of the newer innovations is the monorail and automatic handling system now in operation.

Tuesday, April 16, 1:45 p.m., and *Wednesday, April 17, 8:30 a.m.* Institute for Atomic Research at Iowa State College in Ames. The Ames Laboratory is operated under contract with the Atomic Energy Commission and primarily is concerned with basic, pioneer research in physics, chemistry, and metallurgy. The tour will cover the "Synchrotron" and research buildings. In the research building are the rare earth pilot plant, the hot-canyon room and the hot-loop room all of which are dealing with futuristic research.

Tuesday, April 16, 2:30 p.m. Firestone Tire and Rubber Plant. The Des Moines Firestone Plant represents the newest of its kind, utilizing the latest in manufacturing skills. This plant has produced more than 20 million tires since production was started in 1945. The tour will follow the manufacturing of a tire from crude rubber to finished product.

Committee

The Members of the Great Lakes District Meeting Committee are: K. R. Brown, general chairman; R. H. Miller, finance; R. C. Ringstrand, publicity; F. E. Baird, meeting room; C. C. Doerrie, inspection trips and transportation; J. E. Lagerstrom, technical program; Mrs. N. B. Gussett, ladies program; C. H. Lex, registration and reservation; R. F. Castner, social; A. R. Adams, banquet and luncheons; G. R. Henninger, G. R. Town, L. A. Ware, advisory.

The tentative technical program for the District Meeting follows.

Monday, April 15

9:00 a.m. Registration

9:00 a.m. District Student Papers Contest—North Room

10:00 a.m. General Session—Grand Ballroom

Presiding: J. H. Foote, District vice-president. A welcome will be extended by the Honorable Herschel Loveless, governor of the State of Iowa. The main address will be given by M. S. Coover, president of the Institute.

12:15 p.m. Joint Luncheon with Student Members—Grand Ballroom

Presiding: R. D. Strum of Rose Polytechnic Institute. The speaker will be J. F. Downie Smith, dean of engineering, Iowa State College.

1:15 p.m. District Student Papers Contest—North Room

2:00 p.m. Power System Stability—Green Room

C. C. Doerrie, Westinghouse Electric Corp., presiding

DP.* Limits on Generator Operations due to Overexcitation. *W. G. Kaldenberg*, Iowa Power & Light Co.

57-597. Use of Phase Space in Transient Stability Studies. *S. T. Bow*, Chinese Academy of Science; *J. E. Van Ness*, Northwestern University

DP.* Universal Swing Curves for Two-Machine Stability Problem with Multiple Switching. *A. A. Fouad*, Ein-Shams University; *W. B. Boast*, Iowa State College

2:00 p.m. Magnetic Amplifiers—Flamingo Room

Lloyd Hornback, Iowa Power & Light Co., presiding

DP.* Application of Magnetic Amplifiers to Voltage Regulators and LTC Equipment. *W. J. Denton*, Westinghouse Electric Corp.

57-598. An Analysis of Magnetic Amplifiers in Push-Pull. *D. L. Critchlow*, Carnegie Institute of Technology

57-599. Magnetic Circuits with DC Magnetization and High Alternating Induction. *H. L. Garbarino*, Armour Research Foundation, Illinois Institute of Technology

DP.* Description of a Transistor-Controlled Saturable Reactor for A-C Power Supply Regulation. *D. W. Ford, Robert Tolephson*, Collins Radio Co.

5:30 p.m. Reception honoring President Coover—Grand Ballroom

Tuesday, April 16

9:30 a.m. Distribution—North Room

C. B. Feilmann, Iowa Power & Light Co., presiding

DP.* Problems Encountered in Des Moines Network Conversion. *Yale Goldberg, G. F. Walkup*, Iowa Power & Light Co.

57-600. Estimating Kw Demand for Future Loads on Rural Distribution Systems. *S. J. Vest*, U.S. Department of Agriculture, Rural Electrification Administration

57-601. Determination of Maximum Permissible Voltage Fluctuation Caused by ¾-Ton, 115-Volt Air Conditioning Units. *R. W. Meisner*, Commonwealth Edison Co.

9:30 a.m. Analogs and Computers—Green Room

B. T. Moore, General Electric Co., presiding

DP.* The McIlroy Pipe Line Analyzer. *L. D. Findley*, Midwest Research Institute

* District papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

DP.* **Application of the Network Analyzer to Water Flow Problems.** *P. M. Anderson, J. E. Lagerstrom,* Iowa State College

DP.* **Solution of Simultaneous Equations on the Network Analyzer.** *M. H. Mericle,* Iowa State College

DP.* **Wattmeter Circuits for the 10,000-Cycle Network Analyzer.** *G. E. Fanslow, J. E. Lagerstrom,* Iowa State College

9:30 a.m. Electromechanical Energy Conversion—Flamingo Room

R. G. Brown, Iowa State College, presiding

57-602. **A Unified Approach to the Teaching of Electromechanical Energy Conversion.** *D. C. White, A. Kusko,* Massachusetts Institute of Technology

57-603. **A New Electromechanical Energy Conversion Laboratory.** *D. C. White, H. H. Woodson,* Massachusetts Institute of Technology.

9:30 a.m. Great Lakes District Executive Committee Meeting

Presiding: J. H. Foote, District vice-president

12:15 p.m. Luncheon—Grand Ballroom

Presiding. R. F. Schlenker, Iowa Section Chairman. The speaker will be J. H. Foote, District vice-president.

2:00 p.m. Panel Discussion on the Acquisition of Right-of-Way for Transmission Lines —North Room

J. C. Slothower, Northern States Power Co., presiding

L. E. Slade, vice-president, Iowa Power & Light Co., Des Moines, Iowa

M. B. Hurd, assistant chief engineer, Iowa Public Service Co., Sioux City, Iowa

C. W. Luckritz, head, Land and Tax Dept., Interstate Power Co., Dubuque, Iowa

G. L. England, transmission & distribution engineer, Illinois Power Co., Decatur, Ill.

2:00 p.m. Distribution—Green Room

W. J. Denton, Westinghouse Electric Corp., presiding

DP.* **Distribution Transformers under Overloads—Present Day Methods of Determining Insulation System Life.** *M. L. Manning,* Pennsylvania Transformer Co.

DP.* **A New Approach to Resin Insulation.** *Robert Herr, J. S. Casement,* Minnesota Mining and Manufacturing Co.

DP57-604. **A Two-and-One-Half-Year Demand Growth Cycle.** *C. R. Chapman,* Purdue University

DP.* **Electric Distribution Developments for Serving Future Residential Loads.** *H. G. Hally,* Iowa Power & Light Co.

2:00 p.m. Controls and Control Systems—Flamingo Room

J. D. Bolover, Northwestern Bell Telephone Co., presiding

DP.* **Speed Control of a Prime Mover.** *G. F. Drake,* Woodward Governor Co.

DP.* **Root Locus Method for Compensating a System Containing Complex Poles.** *C. L. Townsend,* Iowa State College

57-605. **Quasi-Optimization of Relay Servos by Use of Discontinuous Damping.** *W. L. Harris, Jr., C. McDonald, Dr. G. J. Thaler,* U. S. Naval Postgraduate School

DP.* **Automatic Control of Electric Power Generation.** *E. H. Preston,* Leeds & Northrup Co.

2:00 p.m. Executive Committee Meeting

6:00 p.m. Social Hour

7:00 p.m. Banquet—Grand Ballroom

Presiding: K. R. Brown, general chairman. The address will be given by E. S. Lee, past president of the Institute whose subject will be, "The Romance of Engineering."

Wednesday, April 17

9:30 a.m. Transmission—North Room

J. E. Luhring, Interchange Power Services, presiding

57-606. **Transmission System Voltages under Single and Double Line-to-Ground Fault Conditions.** *R. W. Johnston,* Iowa Public Service Co.

DP.* **Real and Reactive Power Flow on a Transmission Line.** *J. W. Nilsson,* Iowa State College

57-607. **Rating of Autotransformers for System Interconnection.** *E. T. B. Gross, J. C. Pohlman,* Armour Research Foundation, Illinois Institute of Technology

57-608. **Unbalanced Loading of Three-Phase Transformer Banks.** *S. W. Anderson,* Middle West Service Co.

9:30 a.m. Circuits—Green Room

W. L. Hughes, Iowa State College, presiding

57-609. **Amplitude and Frequency Stabilization of an Oscillator Using Nonlinear Elements.** *C. J. Triska,* Iowa State College

DP.* **A Simplified Physical Picture of Junction Transistors.** *R. H. Mattson,* Iowa State College

57-610. **An Improved Method for Switching Circuit Synthesis.** *D. Zeheb,* General Electric Co. and *L. Depian,* Carnegie Institute of Technology

DP.* **Use of Matrix Methods To Determine the Equivalent Circuit of a Transformer.** *W. L. Cassell,* Iowa State College

"E=IR" Will Be Theme of North Eastern District Meeting

THE THEME "Engineering Equals Industrial Revolution" (E=IR), will be carried out by the North Eastern District Meeting to be held May 1-3, 1957, in Pittsfield, Mass.

The theme will be emphasized by sessions devoted to computers and data processing plus industrial electronics and controls.

Headquarters for the meeting will be the Wendell-Sherwood Hotel in downtown Pittsfield. Three full days of sessions beginning on Wednesday morning with transformers, instrumentation, and industrial control and electronics carry through to Friday afternoon with timely technical papers devoted to nuclear power generation, design and operation of digital computers, and dielec-

United Engineering Center Drive Begins

J. F. LAWRENCE (*second from left*), chairman of the New York Local Section of the American Institute of Chemical Engineers (AIChE), hands a check for $500, the first contribution in a drive for the multimillion dollar United Engineering Center, to W. J. Barrett (*second from right*), president of the United Engineering Trustees (UET), and treasurer of the AIEE. T. M. Jackson, Jr. (*left*), vice-chairman, New York Local Section, AIChE; and W. F. Thompson (*right*), chairman of the Real Estate Committee of UET, observe the presentation. Mr. Lawrence said, in presenting the check, "The contribution represents a decision on the part of the New York Section of the AIChE to devote this major portion of our accumulated funds as a symbolic gesture which we hope will inspire many other engineering and business groups, plus individuals, to follow." In accepting, Mr. Barrett said, "The magnitude of a venture of this size and importance to the American people is such, that it will require 20,000 times this first contribution to build the Center." The total estimated cost of the Center, which will be located in midtown New York, N. Y., is $10 million. The participating societies are: AIEE; AIChE; American Society of Mechanical Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; and American Society of Civil Engineers.

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trics. The well-rounded program contains papers of interest to those in every field of electrical engineering such as utility systems and apparatus, electronics, and industrial applications.

Featured on the program at the Wednesday luncheon will be H. J. Cadwell, president of the local Western Massachusetts Electric Company who will speak in connection with the Yankee Atomic Electric Company. The latter company is constructing New England's first atomic power plant at nearby Rowe, Mass.

The meeting includes inspection trips, social activities, student competitions, and a full calendar of events for ladies.

Reservations

Accommodations have been reserved for AIEE members at the Hotel Wendell-Sherwood. Single rooms are available at $5.50 to $7.85. Double rooms begin at $9.25 and two-room suites can be obtained from $20.00. Reservations should be made directly with the hotel with reference to attending the AIEE Meeting.

Entertainment

A "get-acquainted" reception beginning at 5:30 p.m. on Wednesday evening will permit members to meet others attending. At 8:30 p.m., the Tri-Sectional Competition between members of the Pittsfield, and Lynn, Mass., and Schenectady, N. Y., Chapters will take place. Representatives will vie for honors in the categories of writing and presenting papers they have prepared.

On Thursday evening, beginning at 6:00 p.m. a cocktail party, smorgasbord dinner, and dance will highlight the evening's activities.

Student Activities

Student members will present papers on Friday morning following a special breakfast meeting for student counselors. Representatives of up to 21 schools of electrical engineering will compete for cash prizes plus an expense-paid trip to the AIEE Summer General Meeting for the first prize winner. Counselors and students will join at a luncheon followed by an inspection trip to General Electric's nearby transformer plant in the afternoon.

Inspection Trips

Inspection trips include visits to Crane & Company in nearby Dalton, Mass., on Thursday morning, the Berkshire Woolen Company on Friday morning, and the General Electric Company on Thursday and Friday afternoons.

The complete paper-making process of turning rags into paper will be observed in the Crane Mills. Crane is one of the very few companies producing all-rag content paper. Although the production of United States currency which is made exclusively by Crane & Company cannot be seen, visitors will observe similar processes making either stationery or bond paper. The company museum also will be open.

The trip to the General Electric plant, which produces small cut-outs to the largest power transformers, will feature inspection of the High-Voltage Laboratory where the world's largest man-made lightning stroke has been exploded, the Sound Laboratory including the first anechoic chamber for the measurement of sound in giant electrical apparatus, and the latest giant computer which helps in the designing of power transformers.

Committee

The members of the 1957 North Eastern District Meeting Committee are: J. O. Sweeny, general chairman; J. C. Russ, vice-chairman and Secretary; H. S. Hubbard, adviser; W. A. McMorris, chairman—meetings and papers; B. N. Bowers, chairman—registration and reservations; J. C. Church, chairman—student meeting; F. H. Judkins, chairman—finance; W. A. Williams, chairman—ladies' arrangements; R. M. Butler, chairman—publicity; W. J. Degnan, chairman—inspection trips and transportation; W. F. Dripps, chairman—meeting room arrangements; S. B. Howard, chairman—dinner dance; S. C. Leonard, chairman—smorgasbord; W. G. Deuring, chairman—exhibits; B. A. Cogbill, treasurer and budget chairman.

The tentative technical program for the meeting follows.

Wednesday, May 1

9:30 a.m. Transformers

DP.* **The Application of Transformers with the Insulation Level Reduced Two Classes.** *J. M. Clayton*, Westinghouse Electric Corporation

DP.* **The Effect of Oil Preservation Methods on the Dielectric Strength of Oil.** *R. B. Kaufman, J. L. Pierce, E. R. Uhlig, R. J. Ringlee*, General Electric Company

DP.* **A Way to Get Low Sound Levels in Large Power Transformers—Preassembled Enclosures.** *M. W. Schultz, W. J. McNutt*, General Electric Company

DP57-530. Orthomagnetic Current Transformer for Laboratory and Factory Testing. *L. W. Marks, G. Camilli*, General Electric Company

9:30 a.m. Instrumentation

DP.* **A New Impulse Generator for Cable Testing.** *P. H. Ware, M. J. Koulopoulos*, Simplex Wire and Cable Company

56-899. Precise Determination of the Watthour. *L. E. Janetos, J. J. Hall*, General Electric Company

DP57-556. Instrumentation for Nuclear Power Plants. *R. C. Faught, Jr.*, General Electric Company.

57-407. Solid-State Neutron-Flux Measuring System. *T. S. Gray, W. M. Grim, Jr., F. S. Replogle, R. H. Spencer*, Massachusetts Institute of Technology

DP57-566. Speed Measurement Recorders for Precision Mill Drives. *D. R. Hyer*, General Electric Company

9:30 a.m. Industrial Electronics and Controls

DP.* **The Economic and Technical Aspects of Industrial Electronics.** *Dr. E. D. Cook*, General Electric Company

DP.* **A Self-Balancing Core-Loss Bridge.** *A. H. Foley*, General Electric Company

DP57-563. Feedback Control Principles for Industrial Drives. *C. G. Helmick*, Westinghouse Electric Corporation

DP57-578. Servo Control System for a Large Optical Tracking Instrument. *Morton Mehr*, Perkin-Elmer Corporation

12:00 Noon Welcoming Luncheon

Guest Speaker: H. J. Cadwell, president Western Massachusetts Electric Company

*District papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

VISITORS to the North Eastern District Meeting will have the opportunity to see the recently installed IBM-705 Electronic Data Processing Machine operating at the General Electric Company's power transformer department.

2:00 p.m. Transmission and Distribution

DP57-531. 12.47 Kv Distribution in Southern New England. *P. S. Shelton,* Narragansett Electric Company

DP57-532. The French 380-Kv System Measurement of Corona Losses on Transmission Lines under Normal Operating Conditions. *F. M. Cahen, J. M. Carteron,* Electricite de France, Paris, France

DP57-533. Some Aspects of Surface Voltage Gradient on Power Transmission Lines. *H. B. Dwight,* Massachusetts Institute of Technology

DP57-548. An Approximate Transient Solution of the Tapered Transmission Line. *L. O. Barthold,* General Electric Company

2:00 p.m. Instrumentation

DP57-582. Electrical Interfacial Tensiometer. *E. H. Povey,* Doble Engineering Company

DP57-534. A Fast Null-Balance Electronic Recorder. *W. McAdam, C. E. Miller, J. H. Moore,* Leeds and Northrup Company

DP.* Hushed Transistor Amplifier. *W. K. Volkers,* Millivac Instrument Corporation

DP.* A New Approach to Audio Frequency Impedance Measurement. *H. W. Lamson, I. G. Easton,* General Radio Company

2:00 p.m. Lightning Protective Devices

DP.* Location of Modern Arrester for Transformer Protection. *J. K. Delson, A. J. Schultz,* General Electric Company

DP.* Lightning Protective Requirements in Extra High Voltage Stations. *A. R. Hileman,* Westinghouse Electric Corporation

DP57-594. The New Thyrite Magnevalve Distribution Arrester. *T. J. Carpenter, E. A. Evans, G. E. Desaulniers, E. C. Sakshaug,* General Electric Company

DP.* Expanding System Requirements Indicate Need for More Severe Arrester Tests. *G. F. Lincks,* General Electric Company

Thursday, May 2

9:30 a.m. Transmission and Distribution

DP.* 1956 Lightning Field Investigation on the OVEC 345 Kv System. *W. S. Price, R. H. Schlomann,* American Gas & Electric Service Corporation

DP.* Field Studies of the Surge Response of a 345 Kv Transmission Tower and Ground Wire. *G. D. Breuer,* General Electric Company; *W. S. Price, R. H. Schlomann,* American Gas & Electric Service Corporation; *A. J. Schultz,* General Electric Company

DP.* Lightning Performance of 138 Kv Twin Circuit Transmission Lines of Commonwealth Edison Company—Operating Experience and Field Studies. *R. Caswell,* Commonwealth Edison Company; *I. B. Johnson,* General Electric Company; *E. Koncel,* Commonwealth Edison Company; *N. R. Schultz,* General Electric Company

DP.* Analytical Studies on Lightning Phenomena Involving Towers, Insulator Strings and Transmission Lines. *I. B. Johnson, A. J. Schultz,* General Electric Company

DP.* Suspension Insulator Flashovers under High Impulse Voltages. *Bruce Kingsbury,* General Electric Company

9:30 a.m. Communication and Electronics

DP.* Propagation of Radio Waves via the Troposphere over Distances Far Beyond the Horizon. *J. F. Roche,* Lincoln Laboratory, Massachusetts Institute of Technology.

DP57-574. Current Trend in High Frequency Transistors. *Dr. Kurt Lehovec, R. Zuleeg,* Sprague Electric Company

DP57-536. Low-Level DC-AC Conversion. *E. Keonjian, J. D. Schmidt,* General Electric Company

Future AIEE Meetings

Southern District Meeting*
Hotel Heidelberg, Jackson, Miss.
April 3-5, 1957

Rubber and Plastics Conference*
Mayflower Hotel,
Akron, Ohio
April 8-9, 1957

AIEE-AWS Electric Welding Conference*
Convention Hall,
Philadelphia, Pa.
April 8-12, 1957

Great Lakes District Meeting*
Hotel Fort Des Moines,
Des Moines, Iowa
April 15-17, 1957

AIEE-IRE Solid State Dielectric and Magnetic Devices Conference*
Catholic University,
Washington, D.C.
April 22-23, 1957

Electric Heating Conference*
Commodore Perry Hotel,
Toledo, Ohio
April 23-24, 1957

North Eastern District Meeting*
Wendell-Sherwood Hotel,
Pittsfield, Mass.
May 1-3, 1957

AIEE-IRE-RETMA-WCEMA Electronic Components Conference*
Morrison Hotel, Chicago, Ill.
May 1-3, 1957

East Central-Middle Eastern District Meeting*
Biltmore Hotel, Dayton, Ohio
May 7-9, 1957

Aircraft Electrical Equipment Conference*
Dayton, Ohio
May 7-9, 1957

Domestic Appliances Conference*
Detroit, Mich.
May 20-21, 1957

American Power Conference*
Sherman Hotel, Chicago, Ill.
May 27-29, 1957

AIEE-ISA-IAS National Telemetering Conference*
Cortez Hotel, El Paso, Tex.
May 27-29, 1957

Rectifiers in Industry Conference*
Morrison Hotel, Chicago, Ill.
June 4-5, 1957

Summer General Meeting
Sheraton-Mount Royal Hotel,
Montreal, Que., Canada
June 24-28, 1957
(Final date for †TP—closed, ‡CP Syn—April 9, CPMs—April 19)

Pacific General Meeting
Pasco, Wash.
August 28-30, 1957
(Final date for †TP—May 28, ‡CP Syn—June 14, CPMs—June 24)

AIEE-IRE Magnetic Amplifiers Conference
Penn-Sheraton Hotel,
Pittsburgh, Pa.
September 4-6, 1957
(Final date for †TP—June 4, ‡CP Syn.—June 19, CPMs—June 28)

Petroleum Conference
Philadelphia, Pa.
September 9-11, 1957
(Final date for †TP—June 10, ‡CP Syn.—June 25, CPMs—July 5)

AIEE-IRE Industrial Electronics Conference
Morrison Hotel, Chicago, Ill.
September 24-25, 1957
(Final date for †TP—June 24, ‡CP Syn.—July 10, CPMs—July 19)

AIEE-IRE-RETMA-SMPTE National Electronics Conference
Hotel Sherman, Chicago, Ill.
October 7-9, 1957
(Final date for †TP—July 7, ‡CP Syn.—July 22, CPMs—Aug. 1)

Fall General Meeting
Chicago, Ill.
October 7-11, 1957
(Final date for †TP—June 7, ‡CP Syn.—July 24, CPMs—Aug. 2)

Reliability and Quality Control in Electronics Conference
Silver Spring, Md.
October 10, 1957
(Final date for †TP—July 10, ‡CP Syn.—July 25, CPMs—Aug. 2)

Machine Tool Conference
Hotel Schroeder,
Milwaukee, Wis.
November 4-6, 1957
(Final date for †TP—Aug.5, ‡CP Syn.—Aug. 20, CPMs—Aug. 30)

AIEE-IRE-ACM Eastern Joint Computer Conference
Park Sheraton Hotel
Washington, D.C.
December 8-11, 1957
(Final date for †TP—Sept. 9, ‡CP Syn.—Sept. 24, CPMs—Oct. 4)

Winter General Meeting
Hotel Statler,
New York, N. Y.
February 2-7, 1958
(Final date for †TP—Nov. 1, ‡CP Syn.—Nov. 15, CPMs—Nov. 25)

South West District Meeting
Tulsa, Okla.
March 31-April 2, 1958
(Final date for †TP—Dec. 31, §DP Syn.—Jan. 15, DPMs—Jan. 24)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CP Syn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscipt
(The DP Syn. date is 10 days before the DPMs date)

DP.* Review of Potential Applications of Semiconductor Devices in Television Receivers. *W. F. Palmer, G. Schiess,* Sylvania Electric Products, Inc.

DP.* Transistor Driven Magnetic Counters. *H. N. Putschi,* General Electric Company

9:30 a.m. Electric Heating and Air-Conditioning

DP.* Application of Electrical Equipment to Railway Mobile Freezers. *W. H. Kuklinski,* Carrier Corporation; *D. B. Seymour,* Westinghouse Electric Corporation

DP.* Heat Pumps: Residential, Commercial, and Industrial. *P. F. O'Neil,* General Electric Company

DP.* Compound Air Source Heat-Pump. *H. E. Taylor, P. L. Sackett,* Borg-Warner Corporation

DP.* Heat Losses and Heat Gains in Electrically Heated Homes. *J. B. C. Thomas,* Hartford Electric Light Company; *D. W. Rosebrugh, P. P. Dzubay,* Connecticut Light and Power Company

2:00 p.m. Transmission and Distribution

56-733. A New Approach to the Calculation of the Lightning Performance of Transmission Lines. *C. F. Wagner,* Westinghouse Electric Corporation

DP.* Calculation of Transmission Line Lightning Voltages by Field Concepts. *R. Lundholm,* Goteborg, Sweden; *R. B. Finn, Jr., W. S. Price,* American Gas and Electric Service Corporation

DP.* An Hypothesis Concerning Lightning Phenomena and Transmission Line Flashover. *I. B. Johnson, A. J. Schultz,* General Electric Company

DP.* Factors Affecting the Lightning Performance of Transmission Lines. *J. H. Hagenguth, J. G. Anderson,* General Electric Company

2:00 p.m. Survey of Computers and Their Application

DP.* A Survey of Engineering Applications of Digital Computers. *R. Habermann,* General Electric Company

DP57-562. Progress in Computing. *E. L. Harder,* Westinghouse Electric Corporation

57-558. Analog and Digital Computers in the French Electric Power Production, Transmission, and Distribution Industry. *J. M. Carteron, F. M. Cahen,* Electricite de France

DP.* Application of Computers to Business Systems. *M. E. Salverson,* General Electric Company

2:00 p.m. Electric Heating and Air Conditioning

DP.* Home Heating with Imbedded Wires. *R. C. Cressman,* General Electric Company

DP.* Electric Space Heating and Cooling by Storage of Heated or Chilled Water. *J. M. Turnbull, G. C. Jamison,* Western Massachusetts Electric Company

DP57-546. Operating Costs of an Electrically Heated School. *R. L. Boyd,* Electromode Division, Commercial Controls Corporation

DP57-539. Heat-Pump and Heating-Cables Installed in the Same Residence for Data Purposes. *C. W. Jones, E. E. Linden,* The Narragansett Electric Company

Friday, May 3

9:30 a.m. Student Prize Papers

9:30 a.m. Power Generation

DP.* Application of Relays to Turbine Generators. *P. L. Lloyd,* Westinghouse Electric Corporation

DP.* Steam Turbine Generators with Liquid Cooled Stators. *R. C. Buell,* General Electric Company

DP.* Gas Turbine—An Economic Method of Firming Generation. *W. H. Ferguson,* Westinghouse Electric Corporation

DP.* Application of Gas Turbines for Peak Loads. *H. A. Carlson, J. F. Hill, W. D. Marsh,* General Electric Company

9:30 a.m. Programming and Engineering Applications of Digital Computers

DP57-540. An Application of a Digital Computer to Electric Power Distribution Systems Economics. *R. C. Ender,* General Electric Co.

DP.* Automatic Programming. *Miss S. G. Fleming,* General Electric Company

DP.* Three Years Operating Experience with the Pittsfield Card Programmed Calculator. *H. J. Mason, S. B. Williams,* General Electric Company.

2:00 p.m. Nuclear Power Generation

DP.* Boiling Water Reactor Plants for Power Generation. *D. B. Henderson,* General Electric Company

DP.* Yankee Atomic Electric Plant. *G. A. Read,* Yankee Atomic Electric Company; *R. J. Creagan,* Westinghouse Electric Corporation; *W. C. Woodman,* Stone and Webster Engineering Corporation

DP.* Effect of Nuclear Power on Future Power Systems. *A. G. Mellor,* General Electric Co.

2:00 p.m. Design and Operation of Digital Computers

57-542. Design of Long Passive Oscilloscope Probes to Simplify Maintenance of Large Digital Computers. *W. F. Santelmann, A. J. Hingston,* Lincoln Laboratory, Massachusetts Institute of Technology

DP57-543. A Short-Access Time Memory Using Two Cores per Bit. *R. L. Best,* Lincoln Laboratory, Massachusetts Institute of Technology

DP57-544. Digital Computer Display Systems. *B. M. Gurley,* Lincoln Laboratory, Massachusetts Institute of Technology

2:00 p.m. Dielectrics

DP.* Prebreakdown Currents in Gases in Uniform Fields. *Prof. L. H. Fisher,* New York University

DP57-545. A System of Dielectrics. *C. H. Spaderna,* Norton Company

DP.* A Comparison of Today's Rubber and Rubber-Like Cable Insulation and Jackets. *J. K. Andrews,* Collyer Insulated Wire Company

DP.* Corona Measurements. *W. T. Starr,* General Electric Company

DP.* Re-ignition of Short Arcs at High Pressures. *Prof. L. P. Winsor,* Rensselaer Polytechnic Institute

95 Technical Sessions Held During 1957 Winter General Meeting

THE AIEE Winter General Meeting was held in New York, N.Y., January 21-25, 1957, at the Statler and Sheraton-McAlpin Hotels, the former being the headquarters as usual. Although the total attendance of 4,971 did not equal that of 1956, the number of members and guests exceeded the attendance of the year before, the difference being caused by a drop in student registration due to midyear examinations.

Two scientific events of interest to the electrical engineering world were observed: the 50th anniversary of Dr. Lee de Forrest's triode vacuum tube and the completion of the transatlantic telephone cable last fall.

There were 95 technical sessions and because of the wide variety of the subjects covered, members had little difficulty in finding something of interest every morning and afternoon.

On the social side, there was the Sunday afternoon get-acquainted tea, which has now become a regular Winter Meeting feature; the Eta Kappa Nu Recognition Award Dinner held on Monday evening; and the smoker and dinner dance which were enjoyed as usual. There was a full program of events for the ladies and numerous interesting inspection trips.

Starting on Sunday afternoon, the Institute's committees held meetings from early to late in both hotels and in the Engineering Building. Many Institute members do not seem to realize that it is these meetings that result in the interesting technical sessions and the advance of the art as well as the expediting of the Institute's business. Due credit should be given to these hard-working committee members.

General Session

The General Session on Monday afternoon was opened by the Winter General Meeting Chairman, D. M. Quick, who introduced AIEE President M. S. Coover. In his address, President Coover stressed the need for more guidance in the initial education of the individual (*Electrical Engineering*, pp. 177-78, March 1957).

Prize awards for papers in three Technical Divisions of the Institute were presented by B. G. A. Skrotzki, chairman, AIEE Committee on Prize Awards. Institute prizes were awarded as follows:

Communication Division. First prize to L. S. Schwartz, Hazeltine Electronics Corporation, Little Neck, N. Y., for "Principles of Noise Reduction in Communication Channels"; second prize to L. A. Weber, Bell Telephone Laboratories, New York, N. Y., for "Influence of Noise on Telephone Signaling Circuit Performance."

Power Division. First prize to L. O. Barthold, I. B. Johnson, and A. J. Schultz, General Electric Company, Schenectady, N. Y., for "Switching Surges and Arrester Performance on High Voltage Stations"; second prize to J. S. Tompkins, Aluminum Company of America, Pittsburgh, Pa., L. I. Merrill, Stevens Institute of Technology, Hoboken, N. J., and B. L. Jones, Kansas City, Mo., for "Quantitative Relationships in Conductor Vibration Damping."

Science and Electronics Division. First prize to W. T. Dubic, Westinghouse Electric Corporation, Boston, Mass., C. L. Moore, Westinghouse, Sharon, Pa., and P. A. Zaphyr, Westinghouse, East Pittsburgh, Pa., for "Application of a Digital Computer to the Design of Power Transformers to Specifications"; second prize to A. S. Hoagland, University of California, Berkeley, Calif., for "Magnetic Data Recording Theory."

Student Prizes. First prize to W. B. Bridges, Palo Alto, Calif., University of

MEETING HIGHLIGHTS

AIEE Winter General Meeting

Courtesy Rota Photos

MEMBERS REGISTER (*top picture*) **for the AIEE 1957 Winter General Meeting held at the Hotel Statler, New York, N. Y., January 21-25.** ***Below left:*** **During the general session, AIEE President M. S. Coover (*left*) presents second prize for a student paper to G. D. Green (*center*) and L. M. Hill (*right*), both of the University of Colorado.** ***Below, right:*** **President Coover (*left*), R. C. Sogge (*center*), and K. M. Swezey (*right*) hold a painting of Nikola Tesla's birthplace presented to the Institute by Yugoslavia at the Tesla Centennial held there in the spring of 1956.**

California, for "A Pulse Generator Using Nonlinear Magnetic Cores"; second prize to G. D. Green, Meeker, Colo., and L. M. Hill, Boulder, Colo., both of the University of Colorado for "An Electromechanical Tic Tac Toe Machine."

A highlight of the General Session was the presentation of the Thomas A. Edison Medal to C. A. Adams, past president of the Institute, 1918-19. The presentation was reported in *Electrical Engineering*, March 1957, pages 224-28.

The report of the Nominating Committee was given by W. R. Brownlee, chairman. Nominees are listed on page 243 of the March 1957 issue of *Electrical Engineering*.

The keynote address, "Three-Dimensional Engineers," was presented by F. R. Kappel, president of the American Telephone and Telegraph Company. The text of this address is given on pages 267-70 of this issue.

Technical Sessions

Nucleonics. J. G. Hutton presided at a Monday morning session sponsored by the Committee on Nucleonics. Jack Warren of Singmaster & Breyer discussed the applications of mechanical rectifiers to cyclotrons. It was stated that the mechanical rectifier, after 8 months of operation, is showing itself to be a reliable and efficient power supply for a cyclotron magnet. Automatic current control has been obtained to a fine degree. The inherent dangers, due to the high stored energy in the conductance of the magnet, have been surmounted.

Other papers covered the dynamics and control of nuclear power plants, analog computer study of the transient performance of a dual-cycle boiling-water nuclear power plant, and bias systems for resonant transformer million-volt electron-beam generators.

Domestic and Commercial Applications. This session, with H. F. Hoebel presiding, included an interesting paper on the "Load and Economic Aspects of the Residential Heat Pump on Electric Utility Systems," by C. W. Bary of the Philadelphia Electric Company. Basic physical and economic factors that must be evaluated before the "all-electric home" becomes a reality were discussed. The different type of load, both in its magnitude as well as in its characteristics, requires of the utility business new approaches, new methods, and new concepts to make it economically feasible. The load and economic aspects of the heat pump can be based on facts. The author presents these facts and affords the reader the opportunity to exercise his own judgment in the economic evaluation of this new application in the use of electricity.

Other papers read were "Motor-operated Switch for Space Heating Control," by J. C. Beckett, and "Single-Phase versus Three-Phase Service for Residential Air Conditioning," by A. S. Anderson and C. Hutchinson.

Indicating and Integrating Instruments. This session on Tuesday morning was sponsored by the Indicating and Integrating Instruments Committee with F. K. Harris presiding. The paper "Phase Angle Measurement in the Audio Range," by David Alper of the Bendix Aviation Corporation, provoked lively discussion. The author pointed out the growing need of the armed services and industry for highly accurate phase angle measuring instruments over the range of a full period. An attempt was made at an all inclusive specification for a precise and accurate phase angle measuring instrument. This embraces the factors of input impedance, accuracy and resolution, range of phase angle measurement, permissible wide range of input voltage for both reference signal input and the signal of unknown phase angle, insensitivity to the presence of distortion of signals under test, and most often used frequencies at which critical phase angle measurements are made.

Other papers were "An Inductronic Double Bridge," by J. H. Miller, and "The Clamp-Type Alternating-Current Microammeter," by G. F. Montgomery and C. Stansbury.

Rotating Machinery. At a Tuesday morning session sponsored by the Committee on Rotating Machinery, two papers were given on the subject of d-c machine commutation. The first, by J. R. M. Alger and D. T. Bewley of the General Electric Company, presents an analytical method of determin-

ing bar-to-bar voltage as a function of time during commutation. The results of the method are applied to several large d-c machines and compared with oscillograph data. The second paper, by S. J. Roumanis of General Electric, discusses the analysis of divergence in commutator characteristics. The method of divergence analysis presented indicates that this divergence may be correlated with brush contact drop characteristics.

The session closed with a paper by E. I. Shobert II of the Stackpole Carbon Company on carbon brush friction and chatter.

Safety. A highlight of the Tuesday afternoon session on safety was a discussion of the field treatment of electric shock cases, as presented in a paper by W. B. Kouwenhoven and W. R. Milnor of Johns Hopkins University. (*Electrical Engineering*, March 1957, pp. 220-22). Research has shown that many shock fatalities are caused by ventricular fibrillation of the heart. Prompt application of relatively high electric current through the heart can, in many cases, alleviate this condition, thus reducing the incidence of fatalities. A film showing electrocardiograms of animals demonstrated the effectiveness of this treatment. The film was narrated by Dr. R. W. Chestnut of Johns Hopkins.

Other papers included "A Branch-Circuit Wiring System Used at the National Bureau of Standards," by R. L. Lloyd, and "Lead-Acid Storage Batteries for Emergency Lighting and Power" by E. A. Hoxie of the Electric Storage Battery Company.

Education in Electronics. The theme of this session was the optimum utilization of available manpower and the need for a standardized program to increase the number of engineers available to industry. The discussion centered on the topic: technicians can be trained to work as junior engineers. E. Walker of Pennsylvania State University pointed out that technical aides can be used to advantage much more widely than they are now being used. It is estimated, he said, that 50 to 75% of the work being done in the engineering departments of manufacturing plants in this country can be done as well, if not better, by engineering technicians. Since the potential reservoir of good technician material is four times as great as the potential reservoir of engineers based on I.Q. ratings, the ratio of technician graduates to engineering graduates should reflect this fact. At present, however, twice as many engineers are graduated as technicians. This situation must be reversed not by lowering the number of engineers but by increasing the number of technicians.

K. O. Werwath of the Milwaukee School of Engineering pointed out the total number of technicians being graduated by technical schools today is not even a substantial fraction of the total need.

Production and Application of Light. This session on Wednesday morning was sponsored by the Production and Application of Light Committee with D. Rowten presiding. The paper by J. H. Campbell and Q. D. Dobras, "Development and Application of High Frequency Fluorescent Lighting," approached the question of the practicability of high frequency light from the technical and economic point of view. Economics aside, technological advances have placed high frequency lighting into the present as well as the future. One of the more important developments is the design of circuits and ballasts to operate the high current lamps. In all phases of lighting, the trend is toward higher lighting levels with increasing use of high wattage fluorescent lamps. Today the 96-inch power-groove lamp operates at 200 watts. The future may find lamps of even higher wattage.

Other papers read at the session were "840-Cycle Fluorescent Lighting," by R. H. Burnham, and "High Frequency Power and Distribution," by V. C. Geckler.

Recording and Controlling Instruments. One of the interesting papers presented at the Wednesday morning session on recording and controlling instruments was "The Btu Computer—An Advanced Data System for Industry" by F. W. Hannula, The Foxboro Company. The Btu computer is an instrumentation system which measures the rate at which cooling fluid gains heat, and integrates this rate with respect to time.

Among the other papers presented were one on improved direct-acting electrical recording instruments by E. W. Clark and H. E. Albright of the General Electric Company, and one on the dynamics of electronic self-balancing systems by G. R. Jacob of the Minneapolis-Honeywell Regulator Company.

Wire Communications. J. R. Hyneman presided at a Wednesday afternoon session sponsored by the Wire Communications Systems Committee. Among the papers presented were "A Transistorized Repeater for 45 BN Carrier" by R. H. Fish and V. Babin of the Lenkurt Electric Company and "A Miniature Negative Impedance Voice Repeater Employing Transistors" by A. S. Howell of the Stromberg-Carlson Company.

G. L. Chilberg of the American Telephone and Telegraph Company discussed buried cable telephone distribution systems. Trials are presently in progress in most of the states to determine the feasibility of the new methods and materials recently developed. Mr. Chilberg stated that there is every indication that in the near future it may be possible to provide buried systems at negligible, if any, additional cost, provided conditions are favorable for a buried plant.

Education. Papers read at this session concerned the need for adapting engineering curricula in schools to meet the impact of developments that have resulted from a world war and a decade of uneasy peace with its flourishing programs of sponsored research. W. A. Lynch of the Polytechnic Institute presented a provocative paper on "An Electrical Engineering Curriculum with a Systems Philosophy." Because it is virtually impossible to keep abreast of the technology of electrical engineering, many educators are compelled, the author believes, to teach fundamentals of the basic sciences and the engineering sciences inasmuch as these sciences do not change except in depth and emphasis. This approach should produce in graduates those qualities that are truly essential—a broad scientific background and the ability to think creatively.

Other papers on this theme were "A Philosophy for Electrical Engineering Education" by J. S. Johnson, and "The Dimensions of an Electrical Engineering Education" by F. C. Lindvall and G. D. McCann.

Research. The need for research in overhead transmission of power and related problems was emphasized in a paper entitled "Research Needed on Transmission Limitations" by F. E. Sanford of Commonwealth Associates, Inc. The rate of growth of power loads in the United States points to an increase within the next 15 years of generating capability requirements two to three times the present annual additions. Total plant capacity is expected to double in 10 years and triple within 15 years. Transmissions at 138-kv is the backbone for bulk transfer of power in the United States today. This is related to the unit design of the turbine-generator and transformer installation of approximately 50,000 kw per circuit, but with predicted 500,000 kw generators within 10 years, transmission circuits at 230 kv or 345 kv will be needed to balance with the unit sizes in general or average use and voltages above 400 kv will be needed by many of the larger systems for economical bulk power supply. Related problems of rights-of-way for transmission line construction, and water in vast quantities for cooling and condensing purposes also were emphasized.

System Engineering and Power Generation. At a Thursday morning session sponsored by the Committees on System Engineering and Power Generation, Clark Nicholas presided. A paper by D. H. Cameron and E. L. Mueller of the Kansas City Power and Light Company discussed some of the economic aspects of the General Electric Company automatic fuel-dispatching system at Kansas City Power and Light. The paper describes a method used for evaluating the potential benefits available to an electric utility through the application of incremental loading of generating units, and compares that potential with those actually realized by such loadings.

Other papers presented at the session included "Effect of Speed Governor Dead Band on Tie-Line Power and Frequency Control Performance" by C. Concordia and L. K. Kirchmayer, General Electric Company, and E. A. Szymanski, Wayne University, and "Automatic Economic Dispatching and Load Control—Ohio Edison System" by R. H. Travers, Ohio Edison Company.

Satellite Communications and Satellite Telemetering. Two sessions of great interest were devoted to the electrical aspects of Project Vanguard—the name given to the first artificial satellite which is to be launched sometime later this year. As the six papers were presented by Naval Research Laboratory engineers who designed and worked on the various components, the data contained in them was up to the minute (*Electrical Engineering*, January 1957, pp. 103-05).

The paper given by Dr. H. Friedman,

"Scientific Instrumentation in IGY Satellites," was a broad description of some of the questions which scientists hope will be answered. How many meteors will strike the satellite in a given period? What is the intensity of the hydrogen Lyman alpha line during solar flares? How intense are the X rays emitted by the sun during such periods? What is the geographical and temporal distribution of cosmic rays? What are the variations in the magnetic field around the earth?

The means of gathering the information which it is hoped will answer some of these questions and the apparatus to be used were the subjects covered in the other papers of the sessions.

A related paper was given by J. T. Mengel entitled "Radio Tracking the Earth Satellite." A "fence" of stations equipped to receive radio signals from the satellite will stretch from the United States through Central America down as far south as Santiago, Chile. By means of the 108-mc signals broadcast from the satellite and their reception at the several receiving stations, the speed and direction of the 20-inch sphere can be determined and an orbit plotted. This orbit is expected to be somewhere 200 to 1,500 miles above the earth.

Whitney Matthews in his paper, "Telemetering in Earth Satellites," described the equipment and methods of transmitting the information gathered by the satellite's instruments back to the earth. The 108-mc signals will be amplitude-modulated and provide 48 information channels consisting of 16 high-frequency bursts and 32 time-interval channels.

Industrial Control. A Thursday morning session on industrial control featured four papers on static control systems. The first, by J. C. McMahon and B. P. Chausse of the General Electric Company, describes static switching systems for industrial applications. The second paper, by H. D. Stuart, Westinghouse Electric Corporation, and T. J. Becker, Michigan Drill Head Company, discusses the static digital control of a 6-way milling and drilling tool. The third paper, "Static Control in Automatic Warehousing," was by L. L. Bosch and A. J. Fanthorp of Bosch & LaTour, and J. W. Stuart of Westinghouse. The final paper of the session was "CYPAK Computing Circuits" by J. J. McNeill of Westinghouse. The chief advantage of the CYPAK digital static control system is its reliability; the chief disadvantage, its relatively low speed. The addition, subtraction, and totalizing operations of the system are discussed in this paper.

Transatlantic Telephone Cable. A dramatic demonstration of the role and efficiency of the new transatlantic telephone cable system connecting London, England, to New York, N.Y., and London to Montreal, Que., Canada, took place Thursday afternoon at a joint meeting of the AIEE in New York, the Institution of Electrical Engineers (IEE) in London, and the Engineering Institute of Canada (EIC) in Montreal. The presiding officers were the presidents of the three societies—M. S. Coover, AIEE; Sir Gordon Radley, IEE; and V. McKillop, EIC.

The system serves as a link in wire circuits 10,000 miles long connecting telephone instruments supplied by various administrations and used by peoples of many nations. The essential new connecting links of the system were built under an agreement between the joint owners—American Telephone & Telegraph Co., British Post Office, and the Canadian Telecommunication Corporation.

Prominent engineers and scientists took part in the ceremonies heard simultaneously in the three cities. The transatlantic system provides 29 telephone circuits between London and New York, six telephone circuits between London and Montreal, and a single circuit split between London-New York and London-Montreal. There are also 25 telephone circuits available for local service between Newfoundland and the mainland of Canada.

A feature of the meeting was a demonstration of the high fidelity characteristics of the system: a recording originating in New York compared very favorably with the same recording originating in London.

Feedback Control Systems. A Friday morning session on feedback control systems opened with a paper "A Study of the Transfer Function of Contact-Modulated Amplifiers" by F. H. Krantz, Burroughs Corporation, and O. M. Salati and R. S. Berkowitz, University of Pennsylvania. Kan Chen of the Westinghouse Electric Corporation presented a paper describing a quick method for estimating closed-loop poles of control systems. The proposed method is based on a comprehensive use of the root locus plot and the frequency asymptote plot. The approximate solutions provided by the method have acceptable accuracy for the practical purpose of evaluating the essential characteristics of the transient as well as the steady-state responses of a closed-loop system.

Among other papers presented at the

Courtesy Ross Photos

DURING the Winter Meeting session on the earth satellite, Dr. Herbert Friedman (center) of the Naval Research Laboratory demonstrates Lyman alpha measurement meter, J. T. Mengel (left) also of the Naval Laboratory, is in charge of radio tracking for the satellite. Whitney Matthews (right) is in charge of earth satellite scientific telemetering development at the Naval Research Laboratory.

Courtesy Bell Telephone Laboratories

GRAND BALLROOM of the Hotel Statler, New York, N. Y., during the Transatlantic Telephone Session of the Winter General Meeting.

session were "Adaptive Servomechanisms" by R. F. Drenick and E. A. Shahbender of the Radio Corporation of America, and "The Response of Relay Amplifiers with Feedback" by J. E. Gibson and F. B. Tuteur of Yale University.

Television Equipment Developments. A Friday afternoon session on television equipment was sponsored by the Committee on Television and Aural Broadcasting Systems. In a paper "Transistorized Television Cameras Using the Miniature Vidicon," L. E. Flory of RCA Laboratories described two developments in the television camera field which make use of the latest techniques in transmitter circuitry to achieve portability without sacrificing performance consistent with the proposed uses. A. C. Angus of the General Electric Company described a system of automatic program control for television broadcasting, wherein a ribbon of paper less than 60 feet long can be used to program a television station operation automatically for a full 18-hour period.

Other papers included "Television Translators and Satellites" by Edward Galuska of Adler Electronics, Inc., and "Control of Radiation from FM and TV Receivers" by R. J. Farber of Hazeltine Research Corporation.

Power and High Frequency Tubes. An interesting paper at this Friday morning session was "Rectilinearity of Electron Beam Focusing Fields from Transverse Component Determination" presented by P. P. Cioffi of the Bell Telephone Laboratories. Transverse field determinations provide a sensitive method of evaluating the degree of rectilinearity of electron beam focusing fields. The determinations require the measurement of transverse components of a few tenths of an oersted in a total field of 600 to 800 oersteds. An accurate method of measurement was described by the author which nullifies the error component arising from unavoidable errors of positioning of the test probe with respect to the reference axis. The method is independent of the fields. The high degree of field rectilinearity obtainable, by effective adjustment of transverse field components, establishes the permanent magnet as a precision instrument for focusing high intensity electron beams.

Another paper read at this session was "A Series of Power Triodes Using Coaxial Terminal Construction," by C. V. Weden.

Communication Switching Systems. This session on Friday afternoon was sponsored by the Communication Switching Systems Committee and was presided over by W. Keister. The paper presented by M. Rubinoff, "A New Family of Transistor Switching Circuits," stimulated wide interest. The author recounted the growing use of electronic switching circuits in numerous pieces of equipment in many fields of endeavor. The circuits are carefully designed prototypes intended to serve with utmost reliability and in large numbers in serial or parallel digital computers, in control systems, in communications equipment, or in dial telephone switching offices. The paper described a new "dual-range" family of transistor switching circuits with a number of properties which serve to advantage in switching systems. The component count is smaller than is found in conventional circuits patterned after vacuum tube designs but greater than DCTL systems. The dual-range family offers the possibility of low standby power dissipation and should be capable of higher speed switching than the DCTL family. However both p-n-p and n-p-n transistors are required.

Technical Committee Chairmen Hold Forum During Winter Meeting

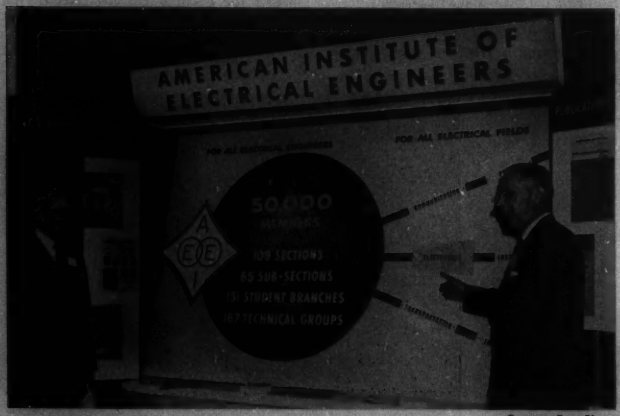
Discuss Technical Division Liaison with Section Technical Groups

THE PRINCIPAL BUSINESS of the Forum of Technical Committee Chairmen, held during the Winter General Meeting, was the discussion of a proposed plan for expansion of the technical divisions organization through the newly appointed Technical Operations Department representatives, one from each district, who in turn would have a Technical Operations Department organization under them extending down into the technical groups in the sections paralleling the national organization of six divisions. The proposed plan, intended to provide channels of communication between the technical groups in the sections and the technical committees and prepared in order to serve as a basis for discussion at the Forum, was published in *Electrical Engineering*, January 1957, pp. 64-7, entitled "The AIEE Technical Divisions" by W. R. Clark, chairman, Technical Operations Department. The meeting was opened by Dr. Clark, who introduced Institute President M. S. Coover, who in turn extended a cordial welcome to the large attendance and emphasized the importance of the technical committee work by referring to the number of committees engaged with approximately 3,000 members.

As background information for the discussion, I. S. Coggeshall, chairman of the Communication Division, outlined the professional groups system of the Institute of Radio Engineers (IRE), which is comprised of 24 professional groups with approximately 50% of the total membership participating. During the year 1955, the 21 groups published 56 issues of *Transactions* containing approximately 3,508 pages and 12 of the groups were on a periodical status. The data were obtained from the *Proceedings of the IRE* for June 1956, pp. 835-7.

As additional background, L. F. Hickernell, chairman of the Planning and Co-ordination Committee, outlined the development of the technical committee organization from the turn of the century, when there were no technical committees, through the time of the Ashville resolution in 1946 when the number of committees were doubled, up to the present time with 49 technical committees in six divisions under the Technical Operations Department with a representative from each district. The data were presented on slides which showed that for a period of time prior to the Ashville resolution there was no growth or normal increase in the number of technical committees.

The proposed plan referred to previously was outlined by Dr. Clark with the objective of encouraging technical group activities and urging technical groups to sponsor technical sessions at district meetings. By increasing the number of publications to six, corresponding to the divisions, it is believed that a direct means of communica-



Courtesy Ross Photos

AIEE PRESIDENT M. S. Coover (*left*) and D. M. Quick (*right*), general chairman for the Winter General Meeting, stand at the AIEE Booth which was exhibited during the meeting.

tion will be provided between the technical groups in the sections and the technical committees, without requiring 48 different group publications. The vice-chairman of the Technical Operations Department, Hendley Blackmon, summarized a survey on the matter which indicated that the districts and sections generally liked the idea of the appointment of a district representative from each district to the Technical Operations Department.

As the proposed plan involved publications, the matter was considered by the Publications Department on the day previous and their opinions were reported by Chairman W. S. Hill. The view was expressed that the present publications are serving the membership very well but that the committee should take a long-range view in respect to plans for the future. Based on the primary interest in technical committees and the secondary interest arbitrarily counted as one half, the following tabulation expressed in per cent of the totals shows a close correlation between the interest and the actual circulation of the three bimonthly publications.

Title	Interest of Members	Technical Papers	Pages	Circulation
Communications & Electronics	32%	26%	32%	36%
Applications & Industry	27	13	15	28
Power Apparatus & Systems	41	61	53	36
TOTAL	100%	100%	100%	100%

This indicates a disproportionate number of papers and pages for 1956. The 68 papers totaling 450 pages in the bimonthly, *Applications and Industry*, represents the entire 1956 production of *Transactions* papers from two divisions; an insufficient number of papers to maintain periodical status for two separate publications.

Chairman Hill explained that in round figures the total cost of all publications was $800,000 a year with a $700.000 income from advertising and publication sales. The bimonthly publications now cost approximately $130,000 with a $15,000 income from subscriptions. To add 16 pages to each issue of the three bimonthly publications in order to include news, excerpts from minutes, and some conference papers would increase the annual cost by approximately $16,000. If the number of bimonthlies could be increased to six different publications on a quarterly basis, the additional annual cost will be approximately $25,000-$30,000.

In conclusion, Chairman Hill said that the problems seem to be those of any decentralization plan. In the final analysis, the Publications Department felt that it might need to work in close liaison with the Technical Operations Department in order to solve some very serious problems which would arise.

Discussion

In the discussion which ensued, various views were expressed both pro and con. J. C. Strasbourger, chairman of the Administration Department, expressed the view that there was a need for closer co-operation between the technical committees and the technical groups in the sections and that 45 new technical groups had been established. Each technical committee chairman was looking for new committee members and the chairmen of the technical groups would be logical choices. Both the chairman of the Sections Committee, Dixon Lewis, and the vice-chairman, Prof. G. T. Harness (West), expressed the view that the autonomy of the sections should be preserved and discussion groups should be free to speak on any subject matter desired. Prof. Dow did not see an easy and direct means of communication between the technical groups and the technical committees but he felt the need for fast publications in the scientific and electronics areas which might be obtained by publishing papers as soon as they are reviewed by the technical committees without withholding them for presentation.

President Coover appointed a special task force comprised of the following: W. R. Clark, chairman; C. E. Dean, C. T. Hatcher, Dixon Lewis, and J. C. Strasbourger for study and evaluation of plans, suggestions, and questions relative to the development of an organizational pattern to serve the technical groups in the sections and provide for their integration into AIEE activities.

Prize Awards for Papers

The chairman of the Prize Awards Committee, B. G. A. Skrotzki, drew attention to the fact that there are prizes for best papers in all six divisions; whereas only about half of the divisions made recommendations. A plea was made for full participation in this activity lest some worthy papers might be overlooked.

Membership Questionnaire

Secretary N. S. Hibshman briefly referred to the questionnaire distributed to the membership last spring. Some 55,000 returns were tabulated by IBM. The very large number of address changes over a period of time necessitating the disposal of standing type for the AIEE Directory has retarded issuance of the directory until late Spring. In addition, the survey attempted to obtain data to determine the business and occupational affiliation of each member for ABC purposes as well as the primary and secondary interests of members in each technical committee area. The total returns in primary interest technical committee areas were distributed at the conference.

Eta Kappa Nu Holds Annual Recognition Award Dinner

SEVERAL HUNDRED MEMBERS and their guests attended the Annual Eta Kappa Nu Recognition Award Dinner held on January 21 during the AIEE Winter General Meeting to recognize the outstanding young electrical engineer of the year 1956. J. D. Ryder, president of Eta Kappa Nu, presided.

The 1956 Eta Kappa Nu Recognition Award was made to J. J. Baruch with the citation, "By virtue of his many notable accomplishments in the field of acoustics, both academically and professionally, and his exceptionally wide interests in cultural and professional activities." The bowl inscribed with names of past recipients which is kept on display in the AIEE Trophy Room was presented to him by President

SHOWN at the Eta Kappa Nu Award Dinner are *(left to right)* R. B. Seidel, president of The Automatic Temperature Control Company, honorable mention winner; Dr. J. R. Ryder, dean of engineering at Michigan State University and president of Eta Kappa Nu; and Dr. J. J. Baruch, vice-president of Bolt, Beranek, and Newman, Inc., who was named the Outstanding Young Electrical Engineer for 1956. Dr. Ryder holds the bronze bowl, kept at AIEE Headquarters, on which are inscribed the names of the previous 20 award winners.

Ryder. Dr. Baruch received his B. S. and M. S. degrees in 1948 and his doctorate in 1950 from the Massachusetts Institute of Technology, where he received the highest grades. Mentioned among his achievements in the field of acoustics were a product for reducing the roar of jet engines, a sound-attenuating unit for reducing noise in air conditioning ducts, and a translucent sound absorbing sheet that may be used as a luminous ceiling material.

The award was accepted by Dr. Baruch as a vote of confidence from a group of people for whom he has a great deal of respect. He stated that electrical engineering was beginning to free people from being slaves to their machines. With considerable foresight, he mentioned the possibility that artificial limbs might be directly controlled from nerve energy. Dr. Baruch is vice-president and director of new products development for Bolt, Beranek, and Newman, Inc., consulting engineers. The introduction and achievements were outlined by Dr. L. L. Beranek.

Honorable mention was awarded to R. B. Seidel with the citation, "By virtue of his outstanding contributions to the development of electric power equipment, his unusual managerial ability and his unselfish devotion to his community and church." Mr. Seidel received his undergraduate degree from Cornell University and his M.S. degree in E.E. from Case Institute of Technology. He is president of the Automatic Temperature Control Company. His achievements were outlined by M. D. Hooven, past-president AIEE, who served as chairman of the Jury of Award. Mr. Hooven stated that this task was a pleasant experience inasmuch as the mechanics were so well arranged by the Award Organization Committee. Altogether, some 100 applicants with remarkable careers were considered by the Jury of Award. All had one thing in common, the fact that they were well read. One other common characteristic was that each applicant was active in his community and church affairs, making it very difficult to choose a winner.

In opening the ceremonies, President Ryder explained that Eta Kappa Nu attempts to undertake programs beneficial to the profession such as the motion picture, "A Career for Tomorrow," which has been widely used throughout the country. In a year and a half, the film has reached 500,000 grade school students. These showings are bound to have an effect on the profession as a whole and serve as an inducement to top level students. Reference was also made to the Eta Kappa Nu survey and graduate reactions to types of jobs. This information is believed to be of great help to industries in their placement activities.

After the ceremonies, a satirical address, "Engineering in the Year 2000" was given by Dr. J. A. Hutcheson, vice-president and director of research, Westinghouse Electric Corporation. Energy sources and essential materials were analyzed in relation to increased consumption as the densely populated countries increased their standards of living.

Important Problems Discussed at Section Representatives Conference

AT THE AIEE Conference Section Representatives and the Sections Committee, held Tuesday, January 22, during the Winter General Meeting, many pertinent problems were discussed including Section allotments and finances, technical groups within the Sections, and public relations activities.

After the meeting was called to order by Dixon Lewis, the presiding officer and chairman of the Sections Committee, R. N. Wagner, secretary, reported on matters discussed at the Sections Committee meeting.

Welcome by President Coover

AIEE President M. S. Coover heartily welcomed the Section Representatives who had attended the meeting in order to exchange ideas and experiences in an attempt to improve Section activities. In a brief talk on the influence and importance of public relations in connection with the electrical engineering profession, President Coover stated that in the engineer's direct or indirect dealings with the public, he must remain conscious of his professional obligation and must indicate to people that he wishes to serve them.

Institute Finances

In his remarks on Institute finances, W. J. Barrett, AIEE treasurer, stated that in terms of net expenditures, Section activities has taken 20% of Institute funds for the years ending April 1955 and 1956 and that the same amount has been budgeted for 1957. In discussing the formation of technical groups in the Sections, Mr. Barrett stated that although the plan may require increased appropriations, it is a very important part of the Institute. He continued by saying that the Section meetings in themselves actually are technical meetings and that the reason why the AIEE exists is so that there may be an exchange of information among people on technical subjects.

Membership Activities

A booklet, Practicle Guide for Membership Committees, was brought to the attention of the representatives by R. K. Fairley, vice-chairman of the Membership Committee. This Guide contains all information necessary for a new Section membership chairman, including a description of the organization and operation of a typical membership committee. In an effort to encourage new membership, Mr. Fairley suggested that next January might be featured as "membership month."

Student Branches

W. B. Morton, chairman of the Student Branches Committee, reported that in the last two years membership has increased 45% in the schools. He urged increased activity in Section Student Branch Committees and also suggested that, inasmuch as many members are lost when students graduate from school and change their location, the branch should notify the Section into which the student is moving.

Transfers

Chairman of the Transfers Committee, R. G. Warner, stated that members of the Institute should be urged to advance up to the limit of their qualifications—to member and fellow grade in the AIEE, and legal registration as professional engineers—in order to increase their own prestige and the prestige of the Institute. To help achieve this goal, each Section should have a Transfers Committee composed of mature men capable of deciding which men are qualified to advance. As an aid, Mr. Warner described a Guide for Transfers, more complete than previous editions, which was issued in September 1956 jointly by the Transfers Committee and the Board of Examiners.

Section Allotments and Finances

E. E. Linden, chairman of the Providence Section, presented a brief discussion of the problems of allotment and finances viewed from the Section's standpoint. He described the various activities of the Providence Section which required a budget of $1,120 for the year. However, the Providence Section is allotted only $633 by the Institute. Mr. Linden offered the following suggestions for increasing Section allotments by (1) unloading national headquarters by collecting dues and conducting national elections; (2) cutting out marginal functions of the Institute to transfer money back to the Sections, (3) operating more efficiently—for example, holding activities in common with the Institute of Radio Engineers (IRE), and (4) allowing corporate sponsorship of AIEE—the sale of formal corporate membership to various electrical manufacturers. Mr. Linden believed that the growth of AIEE will be through the Sections rather than the national headquarters and that, therefore, an investigation of the monetary needs of each would be advisable.

Mr. Lewis explained that a Subcommittee of the Sections Committee had been appointed to look into this problem of Section allotments. J. W. Bennett, chairman of this Subcommittee, explained that the Subcommittee was planning to find out in detail exactly what the problem is, to send questionnaires to the Sections asking for a breakdown of expenditures, to check with Institute headquarters, and, when the information is compiled, to examine the appropriation formula.

Group Dynamics

Dr. T. A. Jackson of Stevenson, Jordan & Harrison, Inc., the management consultant firm engaged by the AIEE, presented an introduction to group-dynamics, a method of encouraging wide and lively participation in a discussion. L. C. Holmes, chairman of the Rochester Section then gave a report of an Area Conference on group-dynamics in which five Sections successfully participated. Following this, the audience divided into groups of six or eight people. Each small group, in a 10-minute "buzz session," decided on one question based on

the topics introduced during the morning. After these questions were collected and written on a blackboard, the discussion began. Among the questions developed were: how the solution of Section problems might be expedited, the advisability of conducting educational courses with fees by Sections, the increase in attendance due to the formation of technical groups in the Sections, and the way in which Sections initiate technical groups.

Public Relations Seminar

The afternoon session of the conference began with a Public Relations Seminar presided over by Fischer Black, chairman of the AIEE Public Relations Committee. After introductory remarks by Mr. Black, President Coover spoke on the value of public relations to the engineering profession and particularly to the AIEE. He gave several suggestions on the ways in which the Section public relations chairman could aid the national Committee.

R. C. Mayer, Jr., of Raymond C. Mayer & Associates, consultants to the AIEE Public Relations Committee, spoke on public relations tools and their use. He described the following tools which are helping AIEE public relations: Public Relations Newsletter; publicity kit; radio kit; Meeting Manual; newspaper mats; "AIEE Today," a condensation of the annual report of the Board of Directors; President's Newsletter, which is sent to the Sections; suggestions for publicizing awards to Section members; Practical Guide for Membership Committees; College Year, an explanation of the student branches; the AIEE Exhibit Booth; Section Operations Manual; The Electrical Engineer; Booklet on Membership; and radio script.

J. J. Kearney, secretary, AIEE Public Relations Committee, spoke on how local section Public Relations Committees are using the public relations tools that were outlined by Mr. Mayer. Mr. Kearney's speech appears in this issue of *Electrical Engineering*, pp. 333-34.

Following this general discussion, particular case histories of public relations at the section level were given by the following members: W. S. Randall, chairman, Public Relations Committee, Connecticut Section; J. J. W. Brown, Public Relations Counsellor, Schenectady Section; and Lee Nonemaker, Public Relations Committee, Lehigh Valley Section.

D. J. McCabe, Student Guidance Committee, Lehigh Valley Section, spoke on sponsorship of student guidance activities. Mr. McCabe discussed the following sources of publicity in relation to the field of student activities: announcements to schools through newspapers; letters to principals and guidance counselors; items in school newspapers; presentation of programs, such as Engineering as a Career with the cooperation of parent-teachers associations; and a science fair.

Technical Group Activity

W. R. Clark, chairman of the Technical Operations Department, spoke briefly on co-ordination between the technical groups of the Sections and the technical committees of the Institute. An article by Dr. Clark on this subject appears in the January 1957 issue of *Electrical Engineering*, pp. 64-75.

Courtesy Ross Photos

AIEE PRESIDENT M. S. Coover welcomes the audience during a meeting of Section representatives held Tuesday, January 22, during the Winter General Meeting.

J. J. Anderson, secretary of the Administration Department, gave a report of the Member Technical Interest Survey. Mr. Anderson stated that during the Summer General Meeting the idea of technical group activity had received an impetus. In September, cards were sent to the secretaries of the Sections to be sent to individual members in order to discover the amount of interest shown in this plan. Officers of the Sections were to make an analysis of the answers. At the Fall General Meeting, the preliminary results showed that there was a 28.1% return within the Sections with 53% of the 110 Sections reporting. The replies indicated that meetings should be arranged only for subjects of major interest. A more recent survey received a 58% reply from the Sections. A breakdown of the Technical Group Questionnaire by Mr. Anderson indicated that 19 Sections have no technical groups and are not planning any, 9 have none but are organizing some, 15 have 3 or less with no new ones planned, 9 have 4 or more with no change indicated, 4 have 3 or less and intend adding some, 2 have 4 or more and are adding new ones, and 1 has less than 3 and is dropping 1.

J. C. Strasburger, chairman of the Administrative Department, presented some suggestions on how to start a technical group, after which a group-dynamics discussion on the topic of technical group activity was organized.

Some of the topics presented for discussion were: the feasibility of technical groups in small Sections with diversified interests, the way in which safety and management groups could be tied in with existing national technical divisions, the level of discussion groups, and meeting places for groups.

Board of Directors Winter Meeting Held in New York, N.Y., January 25, 1957

THE REGULAR Winter Meeting of the Board of Directors was held in connection with the 1957 Winter General Meeting in the Hotel Statler, New York, N.Y., on Friday, January 25, 1957. All members of the Board of Directors, except one, and all of the five Department Chairmen were present. This meeting convened at 9:00 a.m. and adjourned at 5:06 p.m.

Many projects and policies were discussed. Only those on which definite conclusions were reached, or action taken, will be reported in the following brief summary:

Treasurer's Report

The Treasurer reported a balance in the General Fund of $275,075.16, as against the $863,748.62 at the end of December 1956. About $40,000 of this difference is accounted for by the practice inaugurated this year of paying the Section allotments in one lump sum in October rather than half in the fall and half in the spring.

Finances

The Finance Committee requested and was granted increases in budgeted amounts to be paid to such joint bodies as the American Standards Association, Engineers Council for Professional Development, Engineers Joint Council, and United Engineering Trustees, all of which have recently announced increases in their assessments. As of the end of November 1956, 94.2% (per cent) of the budgeted income from current dues had been collected. Income from the collection of dues in arrears had already exceeded by 60% the budgeted expectation. By the end of November, the income from student dues had already exceeded budget

expectation. Other income and expenses as reported up to the end of November were normal.

Constitution and Bylaws

The Board declined to approve a recommendation calling for the discontinuance of the mailed ballot for officers in the case of no contest. Other proposals for major changes in procedures and policies involving Constitutional and Bylaw amendments were tabled.

Section Technical Groups

The Administration Department reported returns from 64 Sections indicating that some 45 new Technical Groups have been organized.

Other Societies

The Board voted to approve the acceptance of the National Society of Professional Engineers (NSPE) as a Constituent member of Engineers Council for Professional Development (ECPD). Two new members of Engineers Joint Council (EJC) were approved—the American Institute of Consulting Engineers, and the Society of American Military Engineers. The reorganization of the EJC Nuclear Congress to include the American Nuclear Society among the active participants was also approved.

New Members and Transfers

The Admissions and Advancements Department presented recommendations for the election of 16 new Fellows of the Institute. Approval was voted unanimously by the Board of Directors in all cases. Their names, pictures, and biographies will appear in a future issue of *Electrical Engineering*.

The following additions to the rolls of the Institute since the October meeting of the Board of Directors were reported. Fellows—16; Members—231; Associate Members—574; Affiliates—92; Students—3,360.

Remission of Dues

On recommendation of the Professional Development and Recognition Department (PDR), the Board of Directors adopted a new policy with regard to the remission of dues in "hardship cases." Heretofore, such remission could be granted only by action of the Board of Directors. Now authority is given to the Secretary to grant remission of dues upon application by the member, or his associates in AIEE, setting forth the facts in the case. The Secretary may accept such applications for relief from members of 15 years or more standing in the case of a disabling accident; or from those who have held membership for 25 years or more, in the case of a disabling illness. Unusual cases may be referred by the Secretary or appealed by the member to the Administration Department for final settlement. The PDR Department also reported favorable prospects for the establishment of several new medals.

Publications

The Publications Department reported an increase of 30% in advertising revenues during the calendar year 1956. It also reported that new contracts had been signed for the printing of *Electrical Engineering* on a basis expected to yield significant savings as a result of the large circulation being adapted to modern high-speed printing machines.

The results of readership surveys being conducted each month by the Editorial Department are yielding significant information for the guidance of the editorial staff and the advertising sales force.

Institute Meetings

The Technical Operations Department reported that the 1958 Winter General Meeting will be held in New York, N.Y., February 2-7. In 1959, and thereafter, the first week in February will be Winter General Meeting time. These new dates are expected to yield a number of advantages, including the availability of as much as 25% more hotel room space.

The 1961 Fall General Meeting will be held in Detroit, Mich., in the week of October 23. The 1961 North Eastern District No. 1 Meeting will be in Syracuse, N.Y., August 27-30. The 1961 Pacific General Meeting will be in Salt Lake City, Utah. The date for the 1958 District No. 7 Meeting in Tulsa, Okla., has now been determined as March 31 through April 2.

Questionnaire

An excellent response was received from the questionnaire sent out last spring covering the Yearbook listing, the industrial and business category, the professional and occupational functions, and interest in technical committees. A total response of over 35,000 was received. Tabulations have been completed and will be reported in an early issue of *Electrical Engineering*.

1957 Annual Meeting

The Board of Directors set the 1957 Annual Meeting to take place in Montreal, Que., Canada, on June 24, 1957. The members who attend the Annual Meeting will be asked to vote on certain changes in the Certificate of Incorporation of AIEE which will be reported in detail in the mailed announcement for the Summer General Meeting and in an early issue of *Electrical Engineering*.

Next Meeting

The next meeting of the Board of Directors will be held on Friday, April 5, 1957, in Jackson, Miss., as a part of the Southern District No. 4 Meeting. It was also decided to hold a meeting of the Board of Directors on August 29, 1957 in Pasco, Wash., as a part of the 1957 Pacific General Meeting.

The invitation of the Washington Section and the Executive Committee of District No. 2 to hold a meeting of the Board of Directors during the 1958 District No. 2 Meeting in Washington, D.C., April 28-30, was accepted.

Nominations for Officers 1957-1958

At the General Session of the Winter General Meeting on Monday afternoon, January 21, 1957, W. R. Brownlee, of Birmingham, Ala., chairman of the 1957 AIEE Nominating Committee announced that the following nominations had been made for the next administrative year.

For President:
W. J. Barrett, Newark, N.J.

For Vice-Presidents:
District No. 2—B. R. Teare, Jr., Pittsburgh, Pa.
District No. 4—H. W. Oetinger, Charlotte, N.C.
District No. 6—A. G. Johnson, Omaha, Nebr.
District No. 8—O. A. Gustafson, San Francisco, Calif.
District No. 10—G. F. Tracy, Toronto, Ont., Canada

For Directors:
W. R. Clark, Philadelphia, Pa.
E. W. Morris, Los Angeles, Calif.
J. C. Strasbourger, Cleveland, Ohio

For Treasurer:
L. F. Hickernell, Hastings on Hudson, N.Y.

AIEE Joint District Meeting To Be Held in Dayton, Ohio, May 7-9

AN AIEE DISTRICT MEETING will be held on May 7-9, 1957, at the Dayton-Biltmore Hotel, Dayton, Ohio. The East Central District No. 11, Middle Eastern District No. 2, and the Institute Air Transportation Committee have combined to present an unusually full program on Rotating Electrical Machinery, Air Transportation, and Engineering Management.

No other section of the country can draw on so many companies involved in such widely diversified types of rotating electrical machinery; and the Air Force Installations and manufacturing concerns interested in aircraft cannot fail to interest the members of the Air Transportation Committee. In addition to the technical paper program, there will be 10 inspection trips, a wide variety of industrial exhibits, and plenty of fun, food, and frolic.

General Session

The general session will be held at the Dayton-Biltmore Hotel at 12:30 p.m. on Tuesday, May 7. D. N. Warren, general chairman of the combined District Meeting will preside.

Hotel Reservations

The facilities of the Dayton-Biltmore Hotel have been completely assigned to the AIEE for this meeting. Requests for room reservations should be mailed to Reservation Clerk, Dayton-Biltmore Hotel, 210 N. Main St., Dayton 2, Ohio. Hotel prices are: single, $6.50 and up; double, $9.00-$11.00; twin beds, $11.50-$14.50; Suites, $28.50-$39.50.

Hotel Reservations should be made as far in advance as possible. Due to the presence

Courtesy National Cash Register Company

Courtesy Air Force Central Museum, W-PAFB

ELECTRONIC posting machine, the Post-Tronic (left), shown in production at factory of the National Cash Register Company. An inspection trip to this company will be held Thursday morning, May 9, during the District Meeting. On Tuesday morning, a reproduction of the original Wright Brothers 1909 airplane (above) will be seen at the Air Force Central Museum, W-PAFB.

in Dayton of another national meeting, and the possibilities that the Dayton-Biltmore might not be able to accommodate all visitors, the Hotel Committee would like time to locate any additional housing facilities that would be necessary.

Registration

The registration desk will be on the fourth floor of the Dayton-Biltmore Hotel and will open at 6 p.m. on Monday, May 6. During the meeting days, registrations will be received from 8 a.m.–5 p.m.

Advance registration will be helpful and appreciated. All fees for social functions and inspection trips will be collected upon registration.

Early Bird Reception

An early bird refreshment and get-acquainted party for members, wives, and guests will be held in the Hilton Room of the Dayton-Biltmore Hotel on Monday evening from 8-10 p.m. All refreshments will be supplied by sponsors in conjunction with District No. 11.

Smoker

Men's smoker will be held on Tuesday, May 7 at 7 p.m. in the Main Ballroom of the Dayton-Biltmore Hotel. Fun is promised for everyone who attends.

Banquet

A banquet for all members, wives, and guests will be held in the Main Ballroom of the Dayton-Biltmore Hotel at 7 p.m. on Wednesday, May 8. Good food and good entertainment are assured.

Inspection Trips

Ten inspection trips are planned to reflect the widest possible range of interest for visitors. Reservations should be made upon registration. AIEE buses will accommodate members and guests on all trips. For trips to Wright-Patterson Air Force Base (excepting the Air Force Central Museum) and Aeroproducts Operations, Allison Division, GMC, some proof of citizenship will be required. A photostat of birth certificate, a company pass that certifies citizenship, or naturalization papers will be adequate.

Air Force Central Museum (Tuesday Morning, May 7). Wives and guests welcome. From captured Japanese and German paintings to the original Wright Brothers glider, the museum will interest and delight all who attend. Its library contains over 675,000 separate documents and photographs. Startling and dramatic exhibits of aircraft and components will bring you up to date on the "Air Age."

Airtemp Division, Chrysler Corporation (Wednesday morning, May 8). Airtemp, Division of Chrysler Corporation, makes air conditioning and heating units for homes, small and large buildings, and automobiles. All vital parts of these products (286 models) are machined and assembled in a 240,000 square foot building. The air in this windowless building is filtered clean and kept at 75 to 78 F the year round. This assures freedom from rust and precise fit of all moving parts. Every air conditioner uses two, and in many cases three electric motors plus overload, low voltage, and operating controls.

Aeroproducts Operations, Allison Division, General Motors Corporation (Wednesday afternoon, May 8). Proof of citizenship required. This is the major United States manufacturer of turbo propellers for prop jet aircraft. Special equipment and process utilized in the manufacture of hollow steel propeller blades are shown the plant visitor. Also manufactured at Aeroproducts are specialized high temperature actuators for after burner control on jet engines and the wing incidence control actuator for the Chance Vaught *F8U* aircraft. Other accessories include ram air driven emergency generators and hydraulic pumps.

A. O. Smith Corporation, Eastern Motor Division (Wednesday afternoon, May 8). This is A. O. Smith's principal motor manufacturing facility— more than 200,000 square feet of floor space. Motors of frame size No. *215* and smaller are assembled in one of the country's most highly conveyorized motor plants. A separate section is devoted to the manufacture of hermetic motors.

National Cash Register Company (Thursday morning, May 9). Guests will visit departments responsible for the engineering of electric motors and other electrical products. Among production operations to be viewed is assembly of the National Post-Tronic, the first electronic bank bookkeeping machine to be placed on the market. The Post-Tronic utilizes electromechanical and electronic principles to simplify the handling of checking accounts in banks. It magnetically "reads and writes" on both the depositor's monthly statement and the bank's records to achieve new levels of accuracy and speed. Production of electric motors will also be viewed. Another demonstration will be a National electronic computer system providing various record-keeping functions at high speed.

Static Test Branch, Aircraft Laboratory and Test Branch, Equipment Laboratory, Wright-Patterson Air Force Base (Thursday morning, May 9). Proof of citizenship required. The Static Test Branch has facilities for determining the structural integrity of air frames. Equipment is available for applying, varying, and controlling both fixed and distributed loadings and for measuring stresses and deflections at numerous points on the airplane. By properly varying loadings dynamic characteristics are simulated.

The Laboratory and Test Branch maintains a very complete and up-to-date environmental test facility. Provisions are available for determining the effects upon equipment of practically any existing natural environment such as heat, cold, moisture, low atmospheric pressure, fungus, vibration, etc. Natural combinations such as heat, moisture, and fungi, or temperature and altitude can be simultaneously achieved. Equipment being tested can either be operated or not depending upon the conditions being simulated.

Delco Products Division, General Motors Corporation (Thursday afternoon, May 9). The new Kettering Plant is one of the most modern of electrical manufacturing units having nearly one-half million square feet of floor space. The plant sits on 308 acres which eventually will be developed with additional manufacturing units. Here are complete manufacturing facilities for polyphase and single-phase industrial and hermetic motors, a-c and d-c generators, and component parts for single-phase fractional motors.

Power Plant Laboratory, Wright-Patterson Air Force Base (Thursday afternoon, May 9). Proof of citizenship required. The Power Plant Laboratory has the responsibility for all prime power equipment including jet engines, turbines, and reciprocating engines. A wide variety of equipment is maintained and operated to determine conformance of power sources to specified requirements.

Armco Steel Corporation, Middletown, Ohio (Thursday evening, May 9). Founded in 1900, Armco is the nation's seventh largest steel company, with a capacity of 5.95 million tons of steel a year. The company is a leading producer of special purpose steels. It is an early developer and one of the country's top producer of electrical steels. Armco's headquarters, general research laboratories, and largest plant are located in Middletown.

Student Program

A District No. 11 student prize paper contest is scheduled for Wednesday, May 8. First prize $50 and the District cup, second prize $40, and third prize $25 will be awarded at the banquet, Wednesday evening. The three winners and their counselors will be guests of the Cleveland Illuminating Company on an all expense paid visit to Cleveland, Ohio.

Ladies Events

Hats and clothing will be covered in short talks and style shows Tuesday and Wednesday. Also on Tuesday and Wednesday, the McCall Corporation will be host to the ladies. Houses, horticulture, and hotel will provide an enjoyable visit at the old stagecoach stop town of Lebanon on Thursday. Located here is Ohio's oldest hotel (the famous Golden Lamb, where lunch will be served), the home of Mulford Nurseries (one of the country's largest producers of house plants), and one of the oldest mansions in the Ohio territory. While the men are "smoking" Tuesday evening at 7 p.m., the ladies will enjoy a party and buffet and participate in a "Let's Arrange Flowers" demonstration. AIEE buses will be on hand for all the trips and the ladies can meet and get a snack in the Hospitality Room at the Dayton-Biltmore which will be open from 9 a.m. to 5 p.m. each day.

General Chairman

D. N. Warren is general chairman of this combined District Meeting and any inquiries pertaining to the business or other information concerning the details of the meeting can be directed to him at Delco Products Division, General Motors Corporation, Dayton 1, Ohio.

The tentative technical program for the meeting follows:

Tuesday, May 7

9:30 a.m. Aeronautical Lighting

Presiding: W. T. Harding

DP.* Lighting Design for Modern Aircraft. *P. H. Greenlee,* Grimes Mfg. Co.

DP57-526. Lighting for Tomorrow's Aircraft. *J. W. Tuttle, M. A. Mortenson,* General Electric Co.

DP57-458. Lighting the Modern Commercial Aircraft. *P. E. Massie,* Day-Ray Products, Inc.

DP57-459. Air Traffic Control and the Jet Age Cockpit. *Dr. Stan Roscoe,* Hughes Aircraft

DP.* Development and Testing Plastic Lighting Plates. *Ben George,* Air Mark Plastics

9:30 a.m. Environmental Design

Presiding: E. K. McMullin

DP.* Design of Liquid-Cooled Aircraft Generators. *D. A. Wilhelmson,* General Electric Co.

DP57-460. Prediction of Transient and Equilibrium Component Temperatures and Evaluation of Cumulative Insulation Damage of Blast-Cooled Machines. *W. Robinson,* Ohio State University

DP57-461. Surface Heat Transfer Coefficients of Salient-Poles in a Blast-Cooled Alternator. *W. Robinson, F. S. Tse,* Ohio State University

DP57-462. Existing and Ultimate Temperature Limitations in Rotating Electric Machinery. *T. H. Putman,* Massachusetts Institute of Technology (MIT)

DP57-463. Thermal Consideration of Generators in High Speed Aircraft. *Alexander Kusko,* MIT

9:30 a.m. Rotating Electrical Machinery

Presiding: L. W. Buchanon

DP57-464. A New Step Motor. *S. Noodleman,* B. A. Wesche Electric Co.

DP57-465. Calculation of Four, Six, and Eight Pole (Two Speed) Split Phase Motors Using Consequent Pole Windings. *T. E. M. Carville, R. F. Fricke,* Westinghouse Electric Corp.

DP57-466. A New Type of Multispeed Motor. *C. S. Siskind,* Purdue University

12:30 p.m. Lunch and General Session

Presiding: D. N. Warren

2:00 p.m. Management Session

Presiding: H. E. Deardorff

DP.* Management in the Electrical Manufacturing Industry. *F. E. Harrell,* Curtiss-Wright Corp.

DP57-467. The Use of Servomechanism Theory in Applying Linear Programming to Business Problems. *Lt. W. R. Greenwood,* W.A.D.C.

DP.* Development of Management Capability Among Practicing Engineers. *A. J. Morgan,* University of Dayton

Wednesday, May 8

9:30 a.m. Jet Transport Electric Systems

Presiding: Mike Trbovich

DP57-468. Brushless Air-Cooled Generators. *R. E. Smith,* Westinghouse

DP57-469. Static Control and Protection of Aircraft Electric Power Systems. *N. F. Schuh, Ronald Hulsey,* Westinghouse

DP.* Voltage Regulator. *Robert Gasperetti, George Steurley,* Westinghouse

DP57-470. Voltage Modulation on Aircraft Electric Power Systems. *R. E. Klokov, C. F. Yohe,* Westinghouse

DP57-471. Design of Generating Equipment for Electra Turboprop Aircraft. *J. M. Alger, W. E. Warden, W. O. Hanson, Leon Klein,* General Electric Co.

9:30 a.m. Environmental Design

Presiding: D. E. Fritz

DP57-472. Ram Air Cooling Systems for Aircraft Generators. *R. M. Moroney,* MIT

DP57-473. Analytical Studies of the Steady-State Off-Design Performance of Ram Air Cooling Systems for Aircraft Generators. *A. K. Sen,* MIT

DP.* A Practical Method of Providing Dynamic Force Isolation for Airborne Equipment. *R. C. Starkey,* North American Aviation

DP.* A Feasibility Study of Materials for Use in Ultra High Temperature Electronic Transformers. *H. B. Harms,* General Electric Co.

DP.* A Report on the Thermal Aspects of Applying Aircraft Rotating Electrical Equipment. Rating of Airborne Electrical Apparatus Subcommittee, AIEE

9:30 a.m. Rotating Electrical Machinery

Presiding: A. E. Hartman

DP57-474. Two-Reaction Theory of a General Induction Machine and Its Equivalent Circuit. *Dr. Y. H. Ku, Dr. D. W. C. Shen,* University of Pennsylvania

DP57-475. The Dilemma of Single-Phase Induction Motor Theory. *P. L. Alger,* General Electric Co.

DP57-476. The Steinmetz Conception of the Single-Phase Squirrel Cage Motor. *Edward Bretch*

2:00 p.m. Aircraft Systems

Presiding: G. W. Sherman

DP57-477. Parallel A-C Generators on a Common Drive. *W. F. McDonnell,* Lockheed Aircraft

DP57-478. The Stability of Aircraft D-C Power Systems with Inverter Loads. *Lt. R. E. Thomas,* W.A.D.C.

DP57-479. A Method of Fault Analysis for A-C Aircraft Electric Power Systems. *R. D. Jessee, L. J. Rindt,* Westinghouse

DP57-480. A Method of Determining the Horsepower Requirements of Aircraft A-C Generators. *T. B. Owens,* Douglas Aircraft

DP.* Reactive Phenomena in Three-Phase Half-Wave Magnetic Amplifiers with Inductive Load. *Dr. H. M. McConnell,* Jack & Heintz

2:00 p.m. Aircraft Systems

Presiding: Robert Lyman

DP.* How To Achieve Aircraft Electrical System Reliability. *John Pierro,* North American Aviation

DP57-481. Some Applications of Magnetic Amplifiers in Aircraft Generator Protective Systems. *D. L. Plette, John Butler,* General Electric Co.

DP.* Co-ordination of Hydraulic Transmissions and Aircraft A-C Generators. *S. C. Caldwell, R. T. Smith, T. E. Coppinger,* General Electric Co.

DP57-482. Development of Definitions and Limits for Frequency Transients and Frequency Modulation in 380 to 420 CPS Aircraft Electric Systems. *O. Markowitz,* N.A.D.C.

DP57-483. Airborne Electrical System Reliability. *C. S. Rea,* Glenn L. Martin Co.

*District papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

DP.* Frequency and Voltage Modulation. *H. I. Horii, C. G. Abendroth,* North American Aviation

2:00 p.m. Rotating Electrical Machinery

Presiding: E. C. Barnes

DP57-484. Electromechanical Technique for Evaluating Effective Insulation Life under Periodic Temperature Variations. *W. D. Munro,* Spencer Thermostat Division, Metals and Controls Corp.

DP57-485. Ventilation and Induction Motors. *F. Myers,* Wagner Electric Corp.

DP57-486. Amortisseur Winding Losses Due to Induced High-Frequency Currents. *P. L. Alger,* General Electric Co.

DP. 57-487. Temperature Tests on Totally Enclosed Nonventilated Motors. *R. F. Woll,* Westinghouse Electric Corp.

Thursday, May 9

2:00 p.m. Power Generation

Presiding: W. T. Beatson

DP57-488. A Method of Determining the Input Power Requirements of Aircraft Generators. *T. B. Owen,* Douglas Aircraft

DP.* Pulse Gate Control Applied to Three-Phase Magnetic Amplifiers. *Dr. A. Krauss,* Jack & Heintz

DP57-489. High Speed Permanent Magnet Alternators. *A. T. Puder, F. Strauss,* Ruckstell, A Division Of General Tire & Rubber Co.

DP57-490. Sintered Plate Nickel-Cadmium Batteries. *L. G. Hector,* Sonotone

DP.* Small Generating Systems for Missiles and Aircraft. *H. S. Sechrist, W. B. Rutledge,* General Electric Co.

9:30 a.m. Power Generation

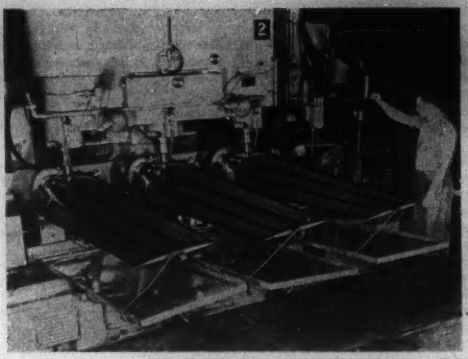
Presiding: Ken Remington

DP57-491. Silver Zinc Batteries as a Source of Primary Electrical Power for a Pilotless Aircraft. *L. T. Abrahamson,* Boeing Aircraft

DP.* Static Exciter for Aircraft Generators. *H. A. Butten, D. L. Plette,* General Electric Co.

DP57-492. Electrical Ignition for Conductive Fuels. *S. J. Sheheen,* Ithaca, N. Y.

DP57-493. Flat Work Coil Design. *B. Matthews,* Manhattan Beach, Calif.



MULTIPLE SPINDLE milling machine (Cincinnati Hydrotel) removing excess material from propeller thrust members by undercutting propeller ribs at Aeroproducts Operations, Allison Division, GMC, which will be visited Wednesday afternoon, May 8, during the District No. 2 and 11 Meeting.

Courtesy Aeroproducts Operations, Allison Division, GMC

DP57-494. The Presence of Informative Feedback in the Control-Stick Motion of a Pilot in Control of an Airplane. *W. D. Diamantides,* Goodyear Aircraft

DP57-495. Generator Torque Calculations. *D. F. Toffolo,* Naval Research Laboratory

9:30 a.m. Rotating Electrical Machinery

Presiding: W. R. Appleman

DP57-496. Stray Load Losses and Stray Torques in Induction Machines. *A. M. Odok,* Louis Allis Co.

DP57-497. Slip-Torque Relationship for Single-Phase Motors. *M. V. Jorgenson,* Louis Allis Co.

DP57-498. A High Power Factor, One Running Capacitor, Two-Motor System. *S. S. L. Chang,* New York University

2:00 p.m. General Topics

Presiding: Dan Forsythe

DP57-499. Aircraft Application of High Starting Torque, Low Inrush Current, 400-Cycle Induction Motors. *S. H. Vogt,* BuAer

DP57-500. Ground Power Equipment. *T. B. Holliday,* Breeze Corporations, Inc.

DP.* Radiation Effects on Electronic Components and Systems. *R. J. Milliron,* W.A.D.C.

DP57-501. The Role of Analog Computers in Propeller Control Design. *Lt. R. K. Frick,* W.A.D.C.

DP57-502. An Approach to Automatic Reduction of Propeller Stress Data—A Digest. *I. A. Peltier,* W.A.D.C.

DP57-503. Design Considerations for Aircraft Relays. *L. E. Massie, E. T. Kotnik,* Convair

2:00 p.m. General Topics

Presiding: Jesse Keyes

DP57-504. Development of High Temperature Aircraft Motor Components. *R. L. Balke,* General Electric Co.

DP.* Solid-State Rectifiers for Electrical Machinery. *Richard Alberts,* W.A.D.C.

DP57-505. An Analytical Study of the Design Parameters for Continuous Strip Fire Control Detection Systems. *J. D. Andrew, Samuel Brand,* Douglas Aircraft

DP.* Five Years Experience with Gas Turbine Generator Sets. *Dr. E. O. Nauman,* Solar Aircraft

DP.* An Electrical Speed and Load Division Control for Constant Speed Air Turbine Drive. *L. G. Norris, P. Dantowitz,* General Electric Co.

DP57-506. A Gas Turbine for a 7-Kva Generating Set. *E. Ritzi,* Lear, Inc.

A CLASSIC SWEEP of line and form from earth to sky describes the Carillon at Deeds Memorial Park, Dayton, Ohio, where the District Meeting will be held.

A Survey of Public Relations Activities at the Section Level

J. J. KEARNEY
ASSOCIATE MEMBER

AS YOU PROBABLY KNOW, the AIEE Public Relation (PR) Committee prepares and disseminates information concerning the Institute and its activities intended for distribution outside the Institute's own publications. It also advises and assists local Section PR committees in handling public relations at the local level.

In an attempt to evaluate its service in this area, the National Public Relations Committee surveyed the Public Relations Committees of local Sections on pertinent public relations activities. Nineteen replies were received to a questionnaire prepared by the Public Relations Committee. This represents about 18% of the Institute's Sections.

The survey showed that although 16 to 19 AIEE Sections have Public Relations Committees, not all of them are taking full advantage of all the public relation tools available. but regardless of size, committees using all of them usually meet with success.

Few Committees Have Vice-Chairman

Membership in these local committees vary in accordance with the size of the Sec-

Mr. Kearney is assistant managing technical editor, *Electrical World,* and secretary of the AIEE Public Relations Committee.

tion. In all instances, full membership was active. However, only 30% have a vice-chairman. Lack of one makes it difficult for the committee to maintain continuity in its activities. The incoming chairman has to become familiar with the nature and scope of public relations work before he can work efficiently and secure good results.

Only half of the section PR committees have regular meetings (those who do usually hold them once a month) or prepare regular reports. Those who do not hold regular meetings are probably missing a good opportunity to expand their public relations activities because an exchange of ideas is a very good approach to finding ways to expand public relations activities. Meetings need not be held monthly, but they should be held often enough to discuss potential activities, investigate new areas worthy of attention, and plan special ways to publicize key events. Public relations is not a cut-and-dried science. It requires free discussion to find the best techniques.

Formal Budget Is Needed

Only 4 of the 19 Sections reporting indicated they had a formal budget for public relations activities. Although it is true that certain public relations functions can be carried out without a committed budget there are certain expenses such as stationery, postage, and printing which must be met if a well-rounded and thorough public relations job is to be performed. Undoubtedly, in many instances, individual companies have given financial assistance for these items and this may account for the lower percentage of local sections having formal budgets.

However, lack of a committed budget makes it difficult for a public relations organization to function properly. It takes money to tell the story. And, furthermore, the monetary expenditure must be adequate. There is no such thing as doing half the job. If the effort is not extensive enough to cover the situation adequately, the expenditure will be completely wasted.

The survey indicated that the publicity kit prepared by the Institute's Public Relations Consultants has been adequately digested and used on the Section level. This kit gives the "where, why, when, and how" of publicity. It gives the local PR man helpful hints in evaluating the need and methods of obtaining good publicity. Sample copies of various types of new releases are contained in the kit. Almost all of the Sections reported that this was a valuable aid in preparing news releases and getting them published.

The Publicity Newsletter was another aid apparently appreciated. This is, as its name implies, an informative letter. It is issued approximately every two months to Section Public Relation Chairmen. Purpose of the Newsletter is to publicize helpful hints on how Sections have actually achieved good publicity results. Yet, despite its acceptance, only two Sections reported making any contributions to it. How much more useful will this Newsletter be when all Sections contribute material about their experiences?

About half of the reporting Sections have used the Meeting Manual to good advantage. This manual contains instructions on practical ways to serve newspapers, radio, television, and the technical and trade press during a meeting. Information in it about newspapers was most helpful. Local PR committees also found suggestions about committee setup and printing important.

Local Awards Night

A new publicity tool is the promotion of a Local Awards Night. It is planned as an event during which formal awards are made to deserving members of the Section. As such, it is a "natural" for publicity.

Despite its newness, Local Awards Night programs were held by one third of the Sections. Generally, members and guests were invited and in some instances students as well as members' wives. The nature of the meeting varied. Some arranged it as a strict business meeting, others a social meeting, and still others a combined business and social meeting. All Sections holding a Local Awards Night program received favorable newspaper coverage.

About one third of the Sections have contacted local radio stations and in all cases but one the response has been favorable. This has been true regardless of the size of the Section. Those who have not approached radio stations have not done so because they do not believe radio would give effective coverage or that the type of material available would warrant such coverage. However, the favorable response received by those who have approached radio stations indicates that this type of coverage should be considered by more local Sections.

Another new aid for local Sections is the President's Letter. It is designed to bring the latest Institute news as quickly as possible to the Sections. Eight issues per year are scheduled. It should be used as an announcement at Section meetings.

The new President's Letter has been used by about one third of the Sections. Some chairmen have read it to the Section. In other instances material from it has been used as "filler" for the Section newsletter.

Newsletters Are Used

Six of the 19 Sections reporting have newsletters. Half of them are mimeographed, two are relief printed, and one is produced by offset. These newsletter are usually a one- or two-page monthly publication put together by the PR committee. It usually contains local news, meeting notices, and some advertising. Lack of money was cited by most Sections not having a newsletter as their reason for not publishing one. In such instances, a joint publication with other allied professional societies may be the solution. Some Sections have tried this type of co-operative venture with apparent success.

Most of the reporting Sections indicate the publicity kit is the most helpful PR tool. The Public Relation Newsletter was also considered very useful.

Local meetings have generally been publicized by direct mail notices, by local newspaper notices, and use of local engineering journals. But quite a number indicated the successful use of company house organs and bulletin boards.

Lamme Medal for 1956 Awarded to Dr. H. H. Beverage

The Lamme Medal for 1956 has been awarded to Dr. H. H. Beverage (AM '23, F '48), director of Radio Research Laboratory, Radio Corporation of America (RCA), ". . . for his pioneering and outstanding engineering achievements in the conception and application of principles basic to progress in national and worldwide radio communication."

Courtesy Curchack-Kalayjian

H. H. Beverage

The presentation ceremony will take place on June 24, 1957, during the AIEE Summer General Meeting in Montreal, Que., Canada.

Dr. Beverage was born at North Haven, Maine, October 14, 1893. Following his graduation from the University of Maine in 1915, he was employed by the General Electric Company in the radio laboratory of Dr. E. F. W. Alexanderson. In 1920, Dr. Alexanderson was appointed as the first chief engineer for the newly formed Radio Corporation of America, and Dr. Beverage was transferred to that organization to head a laboratory concerned with radio propagation and the development of transoceanic radio receiving systems. Dr. Beverage was appointed chief research engineer of RCA Communications, Inc., in 1929, and became vice-president in charge of research and development in 1940. In 1942, Dr. Beverage also became associated with RCA Laboratories and is presently director of radio research for that organization.

Dr. Beverage holds about 40 patents and is co-inventor of the wave antenna and the diversity system for high frequency reception. He is a Fellow of the Institute of Radio Engineers (IRE), American Association for the Advancement of Science, and the Radio Club of America. He was president of the IRE for 1937 and received the Liebmann Memorial Prize in 1925, and the Medal of Honor in 1945, from that society. He received the degree of D. Eng. from the University of Maine in 1938. Other honors include the Armstrong Medal from the Radio Club of America in 1938, Radio Pioneer Award from the National Association of Broadcasters in 1940, Signal Corps Certificate of Appreciation in 1944, and the Presidential Certificate of Merit in 1948. He

was elected Eminent Member of Eta Kappa Nu in 1955. From 1942 to 1946, he was part-time consultant to the Office of the Secretary of War and made several trips to the North Atlantic stations of the Air Force and to the European Theatre and Alaska in connection with military communication problems.

AIEE Michigan Section Holds Power Group Meeting

The Technical Meetings Group on Power of the Michigan Section AIEE held a meeting in the new Meter Building of the Consumers Power Company on January 15, 1957 in Jackson, Mich. Three talks were heard on the subject "Solutions to Distribution System Problems—Present and Future." These talks were presented by C. E. Asbury, supervisor of system planning of Commonwealth Associates Inc.; J. R. Frey, system planning engineer of Consumers Power Co.; and Wylie Groves, chief planning engineer of the Detroit Edison Company. Approximately 150 engineers from Detroit, Ann Arbor, Lansing, and Jackson braved zero degree weather to attend.

Mr. Asbury discussed some of the more important engineering and economic problems of distribution such as alternate methods of providing service. He introduced his talk with a very interesting description of the first distribution systems that were built by Thomas Edison.

Mr. Frey discussed some of the problems caused by the customer, stating that the customers determine the type of distribution system used. One of the biggest problems in distribution today is electric house heating and how to meet it.

Mr. Groves talked on some of the non-engineering problems of distribution, such as acquiring substation sites and making them acceptable to the surrounding landowners. He told of many of his experiences with zoning boards.

F. A. Denbrock of Commonwealth Associates Inc. was chairman of the meeting and was assisted by K. C. Goodwin of Consumers Power Co. J. A. Jancar of Westinghouse Electric Corporation, Detroit, was the moderator for the meeting.

THE MODERATOR and three speakers for the AIEE Michigan Section Power Group Meeting were *(left to right)* J. A. Jancar, C. E. Asbury, Wylie Groves and J. R. Frey.

Courtesy Jackson Citizen Patriot

Many Events Planned for 1957 Summer General Meeting

The Entertainment Committee of The AIEE 1957 Summer General Meeting to be held in Montreal, Que., Canada, June 24-28, is planning a number of entertaining events for those who attend.

On Sunday afternoon, June 23, between 3 and 5 p.m. there will be an afternoon tea in the Sheraton-Mount Royal.

Golf tournaments will be played on Tuesday, June 25, and Wednesday, June 26. The first day will be used as a qualifying 18 holes for the Mershon Trophy. The four lowest net scores will qualify their holders to play match play for this trophy on Wednesday. A qualifying figure will be set on the first 18 holes to limit the number of contestants playing on the second day for the Lee Trophy. Arrangements will be made to permit delegates and their wives to play golf at their leisure at other courses around Montreal. Club privileges will also be obtained for the delegates wishing to play tennis.

Tuesday evening the Smoker Committee has arranged a dinner, to be followed by entertainment.

On Thursday, June 27, a member's identification badge will be his entrance fee to the President's Reception. A dinner and an informal dance will follow.

For the ladies a Committee is organizing special events which include for Tuesday June 25, a special evening at the Bellevue Casino Club. On Wednesday June 26, there will be a bus trip to Laurentian Mountain resorts; lunch will be served at the Chanteclair. On Thursday June 27, the ladies Committee has organized a sight-seeing tour around Montreal. On that occasion the City of Montreal will play host to the ladies and serve tea on historic St. Helen's Island.

The following inspection trips have been arranged:

Trip No. 1 Limited to 44 men, June 25. Full day trip at the Bersimis Power Development Via T.C.A. chartered aircraft.

Trip No. 2 For 50 delegates, June 25. Morning trip to Hydro-Quebec Service Centre to see microwave equipment.

Trip No. 3 For 100 delegates, June 25. After noon trip to Lachine to see hydroelectric turbine and pump manufacture, and Test Laboratory.

Trip No. 4 For 75 delegates, June 26. Morning trip to Montreal Locomotive Works Plant—emphasis on diesel electric locomotive production.

Trip No. 5 For 100 delegates, June 26. Afternoon trip to The St. Lawrence Seaway, to see the work in the Lachine section extending to Beauharnois.

Trip No. 6 For 100 delegates, June 26. Afternoon trip to Beauharnois Power House.

Trip No. 7 For 75 delegates, June 27. Full day trip to Quebec Iron and Titanium Smelter Plant at St. Joseph de Sorel and to Shawinigan Water and Power Company's 230-kv Terminal Station at St. Joseph de Sorel.

Electric Heating Conference Will Be Held April 23-24, 1957

On Tuesday, April 23, and Wednesday, April 24, 1957, the Third Biennial AIEE Conference on Electric Heating will be held in the Commodore Perry Hotel at Toledo, Ohio, under the joint sponsorship of the Electric Heating Committee, Industry Division, and the Toledo Section of the AIEE. This conference is somewhat of a departure from some engineering meetings, in that it is entirely for the benefit of those who are not necessarily experts in the field. It emphasizes the practical, rather than theoretical, aspects of industrial heating methods and equipment.

The conference will open with a basic refresher session on the fundamentals of resistance, radiant, dielectric, and induction heating. It will close with four concurrent workshops where members of the audience will meet and have the opportunity to chat with the experts in each of the foregoing fields.

An illustrated, bound booklet of the papers to be presented will be included as a part of the registration fee. These booklets will be distributed at the conference, and additional copies will be available at a nominal charge.

It is hoped that a large number of people in the engineering and design departments of manufacturing concerns will be reached. It is important to familiarize the men who actually write specifications with the various forms of industrial electric heating. This applies to people in plant engineering departments—process engineers, product designers, and draftsmen.

F. W. McCloska Speaks at Iowa-Illinois Section Meeting

The January meeting of the Iowa-Illinois Section AIEE was held on Tuesday, January 15, 1957, at the Tower restaurant in Moline, Ill. A family style chicken dinner was served prior to the meeting.

The speaker of the evening was F. W. McCloska (M '46) of Sargent and Lundy,

consulting engineers, Chicago, Ill. His subject was "Extra High Voltage Transmission." Mr. McCloska discussed the development work, technical problems, and the economics of 345-kv transmission. As a partner of Sargent and Lundy, he has worked on two of the present 345-kv lines namely, the one for the Atomic Energy Commission at Portsmouth, Ohio, and the one for the Commonwealth Edison Co. near Chicago, Ill.

The District AIEE Vice-President, J. H. Foote was also present at the meeting and gave a short talk on the reasons for vice-president visitations and also on some of the national objectives of AIEE.

Ninth Conference Being Held by Rubber and Plastics Subcommittee

The Ninth Conference on Rubber and Plastics will be held in Akron, Ohio, at the Mayflower Hotel, April 8-9, 1957. This conference is sponsored by the AIEE Rubber and Plastics Subcommittee of the General Industry Applications Committee.

The tentative technical program for the conference follows.

Monday, April 8

9:00 a.m. Opening Session
Keynote Address: Dan Pellett, B. F. Goodrich Co.

9:45 a.m. Session 1
Adjustable Speed Drives—Electrical, Hydraulic, and Mechanical—Their Application to Rubber Processing Equipment. ***Wilbur Jones,*** **Goodyear Tire & Rubber Co.**

11:00 a.m. Session 2
Electric Motor Braking Methods for Rubber and Plastics Industries. ***J. G. Ponstingl,*** **Westinghouse Electric Corporation**

12:00 Noon. Luncheon Recess

2:30 p.m. Session 3
Design Features of Electrical Installations for Areas which Are Hazardous because of Flammable Vapors and Combustible Dusts. ***C. M. Park,*** **Mill Mutual Fire Prevention Bureau**

3:45 p.m. Session 4
Electrical Safety Standards. ***P. T. Powell,*** **U. S. Rubber Co.**

5:30 p.m. Cocktail Hour

6:30 p.m. Banquet
Address: M. F. Gigliotte, Monsanto Chemical Co. Subject: Plastics as an Engineering Material of Construction

Tuesday, April 9

9:00 a.m. Session 5
Aluminum Conductors. ***R. R. Cope,*** **Aluminum Company of America**

10:45 a.m. Session 6
Programming. ***L. F. Lewis,*** **General Electric Company**

12:00 Noon. Luncheon Recess

2:30 p.m. Session 7
Special Drive for Rapid and Accurate Cycling. ***Tom Jones,*** **National Rubber Machinery Co.**

3:45 p.m. Session 8
Subcommittee Reports

Problems Due to Atmospheric Contamination. ***E. L. Smith,*** **chairman**
Standardization for Rubber and Plastics Industries. ***W. S. Watkins,*** **chairman**

Final Plans Made for Conference on Power Rectifiers

Final plans for the Conference on Power Rectifiers, sponsored jointly by the Semiconductor-Metallic Rectifier and Industrial Power Rectifier Committees of AIEE, to be held at the Morrison Hotel in Chicago, Ill., June 4-5 were agreed upon at a recent meeting of the Executive Committee in charge of this conference.

A total of 4 sessions will be held during which 16 papers will be presented. Three sessions will be conducted in a manner similar to conventional Institute technical sessions with the speaker being given 20 to 25 minutes for presentation and 15 to 20 minutes being allotted for discussion from the floor. The papers will cover subjects such as general theory and basic principles, fields of application of various types of rectifiers, progress in standardization—both national and international—application practices, and operation and maintenance. These papers will be principally concerned with mercury arc, metallic and semiconductor rectifiers for power service where installation ratings range from a few hundred amperes to over 100,000 amperes.

The highlight of the conference will be a panel discussion on application and maintenance. The symposium will begin with a short presentation on experience in each of the following fields: (1) low voltage electrochemical, (2) low voltage plating, (3) high voltage electrochemical, and (4) steel mill auxiliaries and main drives. The presentation will be made by an eminent user in the field. These four men plus two representatives of the manufacturers will comprise the panel which will answer questions from the floor. Informal discussion from the audience drawing upon their experience in these fields will be welcomed and encouraged.

All papers presented at the conference will be published in a bound booklet which will be available at the registration desk for $4 each.

Because a large attendance is anticipated, the Constitution Room, which accommodates 500 people, has been reserved for the technical sessions.

Dr. C. A. Adams To Be Honored by the American Welding Society

A complete sellout of available space for the fifth welding show sponsored by the American Welding Society two months before the opening will make the show the largest in its history.

Scheduled for Convention Hall, Philadelphia, Pa., April 9-11, 1957, the exposition will be 30% larger than the largest of the previous expositions. During the same week, April 8-12, inclusive, the society will hold its annual meeting and technical sessions at the Hotel Sheraton, Philadelphia, Pa.

Both the show and other meetings will honor Dr. C. A. Adams (F '13), frequently called the dean of American engineers, who founded the American Welding Society. The show has been renamed "The Adams National Show," and a banquet, "The Adams National Dinner," will be tendered in his honor.

The AIEE, which recently awarded its 1956 Edison Medal to Dr. Adams, will join in the sponsorship of several of the technical sessions.

Ninety research experts will participate in the reading of papers on recent welding developments.

D. C. Smith, chief metallurgist, Harnischfeger Corp., Milwaukee, Wis., will deliver the society's annual Adams Lecture.

Other activities scheduled include a practical welding conference, of nontechnical nature, at Convention Hall, and conducted tours of industrial plants in the Philadelphia area.

Advance registration tickets and hotel information may be obtained from R. T. Kenworthy, exposition management, 12 E. 41 St., New York 17, N.Y.

Three papers will be read at each of 18 technical sessions. The tentative program follows.

Monday, April 8

Morning
Business Session
Address by J. J. Chyle, society president
National Awards
Adams Lecture by D. C. Smith: "Evolution of the High-Tensile Weld Metal with Low Hydrogen Electrodes"

Afternoon
Nuclear Reactors and Irradiation Effects
Weldability and Research
Applications

Tuesday, April 9

Morning
Nuclear Reactors and Irradiations Effects
Resistance Welding
Research and Applications

Afternoon
Resistance Welding
Weldability and Research
Structures

Wednesday, April 10

Morning
Resistance Welding
Weldability and Research
Design and Application

Thursday, April 11

Morning
Arc Welding
Titanium and Zirconium
Brazing

Friday, April 12

Morning
Gas-Shielded Welding
Pressure Vessels
Surfacing, Brazing, and Soldering

IRE Establishes W. R. G. Baker Award

The Board of Directors of the Institute of Radio Engineers (IRE) has announced the establishment of a new IRE award, to be known as the W. R. G. Baker Award, to be given annually to the author of the best paper published in the *Transactions* of the IRE Professional Groups.

The award will consist of a certificate together with a cash award comprising the income of a fund donated to the IRE by Dr. W. R. G. Baker (F '47), vice-president of the General Electric Company and chairman of the IRE Professional Groups Committee.

The 1957 W. R. G. Baker Award will go jointly to Messrs. Kircher of Hughes Aircraft Company, and Trent and Fewer of Bell Telephone Laboratories for the following series of three papers which appeared in the IRE *Transactions on Audio*: "Properties of Junction Transistors" by R. J. Kircher, IRE *Transactions on Audio*, No. 4, July-August, 1955; "Design Principles of Junction Transistor Audio Amplifiers" by R. L. Trent, IRE *Transactions on Audio*, No. 5, September-October, 1955; "Design Principles for Junction Transistor Audio Power Amplifiers" by D. R. Fewer, IRE *Transactions on Audio*, No. 6, November-December, 1955.

24th Annual Report Is Published by ECPD

Engineers' Council for Professional Development (ECPD) has published its 24th Annual Report, covering the administrative year 1955-56.

Prominent in the Annual Report are individual reports by the following ECPD committees: Guidance Committee, Education and Accreditation Committee, Student Development Committee, Training Committee, Recognition Committee, Ethics Committee, Information Committee, ECPD-Engineers Joint Council (EJC) Joint Committee on Practice of Engineering, and ECPD-EJC Joint Task Committee on Engineering Profession Survey.

Also included are highlights of the 24th Annual Meeting of ECPD, held October 25-26, 1956, in Detroit, Mich., and reports of the representatives of the constituent organizations of ECPD, one of which is the AIEE.

One of the important functions of ECPD is the accrediting of curricula leading to engineers degrees. A list of institutions in the United States accredited by the organization is contained in the Annual Report as well as a list of Canadian universities offering courses in engineering subjects.

Among the publications offered by ECPD which are described in the Annual Report are Accredited Curricula Leading to First Degrees in Engineering in the United States, 1956; and Accredited Technical Institute Programs in the United States, 1956. These booklets may be obtained from ECPD, 29 West 39th St., New York 18, N. Y., 25¢ each. The 24th Annual Report may also be obtained for the price of $1.

Connecticut Subsection Visits U.S. Navy Underwater Sound Lab

The newly formed New London Subsection of the Connecticut Section of AIEE recently sponsored a meeting in New London, Conn., at the U.S. Navy Underwater Sound Laboratory. This meeting was arranged essentially for the student members of the University of Connecticut at Storrs. A tour of the facilities was arranged through J. A. Wheeler and F. N. Sentell of the Sound Laboratories. The student advisor from the electrical engineering department of the University of Connecticut was H. Lucal.

The New London Subsection covering the southeastern area of Connecticut was formed in September 1956 under the direction of W. A. Upham, chairman of the Connecticut Section. The Chairman of the Subsection, A. E. McClarren, is with the Electric Boat Division, General Dynamics Corp., Groton, Conn. The Executive Committee of the Subsection is composed of Mr. McClarren; Theodore Braaten, a past chairman of the Connecticut Section; R. M. Bowers, secretary-treasurer; C. F. Luby; J. L. Randall; and E. P. Rivard.

The Subsection, in addition to this recent meeting, has sponsored two other meetings, one on "The Professional Engineer," and one on "U.S. Satellite Development as Part of the Geophysical Year Celebration," both held at the U.S. Coast Guard Academy.

Additional Conference Papers Are Now Available

The following is the list of conference papers presented at the 1957 Winter General Meeting, New York, N. Y., January 21-25, which were not numbered at the time of the meeting. They have now been numbered and are available to members for 40¢, and to nonmembers for 80¢. Send order and remittance to: AIEE Order Department, 33 West 39 St., New York 18, N. Y.

CP57-232 Television Translators and Satellites. *Benjamin Adler*

233 Corona Measurements on Oil-Insulated Transformers. *E. Adolphson, F. J. Vogel*

235 Phase Angle Measurements in the Audio Range. *David Alper*

236 Automatic Program Control for Television Broadcasting. *A. G. Angus*

238 Switching Surges on Switching a Line and Transformer as a Unit. *L. O. Barthold, I. B. Johnson, A. J. Schultz*

CP57-239 The Gassing of Liquid Dielectrics under Electric Stress—The Influence of Voltage and Pressure. *H. Basseches, Mrs. M. W. Barnes*

241 Evaluation of Operating Principles with Microwave Relaying. *J. Berdy, H. J. Fiedler, F. C. Krings, A. J. McConnell*

243 Advancements in the Facsimile Art during 1956. *W. H. Bliss*

246 The Effects of Radiation on Mylar. *E. L. Brancato*

247 Report on Progress and Trends in European Electrification. *E. H. Brown, C. B. Lewis, D. R. MacLeod*

250 Four-Inch Diameter Motors for Submersible Water Well Systems. *M. J. Carroccio*

252 The ECPD Program in the Field of Professional Ethics. *C. T. Chave*

257 Thermal Aging of Elongated Enameled Wire. *Dean Westervelt, E. J. Croop*

258 Effects of Arcs on Silicone Liquid Dielectrics. *C. G. Currin, J. F. Dexter*

259 A Dual Circuit Electronic Regulator. *J. J. Dailey, Jr.*

264 A Pioneer 230-Kv Pipe Cable Installation. *W. A. DelMar, E. J. Merrell, J. H. Nicholas*

266 Operating Characteristics of High Capacity Air-Break Contactors on Industrial Power Systems. *S. R. Durand, Thad Bellinger*

267 Load Dispatching in a Large Industrial Plant. *J. R. Eckert, J. M. Petruska*

269 Electrostatic Recording and Reproducing Devices. *H. Epstein, G. R. Mott*

270 Control of Radiation from FM and TV Receivers. *R. J. Farber*

271 Numerical Analysis of Physical Systems Using Digital Computers. *R. W. Ferguson, P. A. Zaphyr, E. L. Harder*

272 A Transistorized Repeater for 45 BN Carrier. *R. H. Fish, V. Babin*

273 Transistorized Television Cameras Using the Miniature Vidicon. *L. E. Flory*

382 Rectifier Locomotives for the Virginian Railway. *J. C. Fox, J. P. Wiles*

225 A New "De-Ion" Air Breaker for 750 Mva, 13.8 Kc. *Russell Frink, J. M. Kozlovic*

274 New Noise Sources for Monitoring the Performance of Microwave Systems. *R. H. Geiger*

275 Heat Flow in D-C Motor Field Coils as a Function of Insulation Deterioration. *G. P. Gibson, J. G. Schwarzkopf*

277 The Effect of Rate of Irradiation on the Breakdown Strength for Kel-F. *J. Goodman*

278 A Curriculum in Computer Applications at the Moore School. *S. Gorn, A. Matz, G. W. Patterson*

Official Photograph, U. S. Navy

A MEETING at the U. S. Navy Underwater Sound Laboratory was sponsored recently by the New London Subsection of the AIEE Connecticut Section. A tour of the facilities was also arranged.

CP57-279 The Polyethylenes for Higher Voltage Cables. *R. C. Graham*

280 Thermal Stability of Flexible Sheet Insulation Using Wrapped Bar Method. *R. L. Griffeth*

282 Application of Computers to the Analysis of Sudden Short-Circuit Oscillograms. *D. B. Harrington, J. K. Whittlesey*

284 The D-C Conductivity of Simple Chlorinated Hydrocarbons. *J. Hart, A. G. Mungall*

285 Design Considerations for Rectifiers for Railway Locomotives. *C. C. Herskind, J. E. Hudson, W. R. Kettering*

286 Research in Europe for American Industry. *J. E. Hobson*

287 Plant's Power Distribution System Has Face Lifting. *E. H. Howard*

289 Modern Requirements for Oil Well Pumping. *J. K. Howell, S. S. Brone*

292 The Use of Pipe-to-Soil Potential Measurements in Determining the Corrosion of Underground Pipe Lines. *Bernard Husock*

294 The Arithmetic Design of the Nordic Computer. *T. A. Jeeves, W. D. Rowe*

295 A High Voltage Surge Test for Detecting Faults between Turns of Rotating Machinery. *J. S. Johnson, R. E. Kelly*

296 High Frequency Fluorescent vs Standard Fluorescent Lighting Systems. *W. H. Johnson, J. Winpisinger*

297 RCA Multiplex/ARQ System. *A. Kahn, A. Liguori*

298 Optimal Utilization and Expansion of Interoffice Trunking Facilities. *R. E. Kalaba, M. L. Juncosa*

299 Low-Sound Transformers. *G. K. Kallenbach, M. W. Schultz, Jr., T. J. Twomey*

300 Color Television Recording Employing Lenticular Film. *R. D. Kell*

301 Design of a Medium Power Ceramic Tetrode. *J. W. Kendall, Jr.*

303 The Effects of Radiation on the Properties of Dielectric Materials. *P. H. Klein*

304 Arrestor and Capacitor Location on Industrial Power Systems. *A. Knable, D. Dalasta*

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

CP57-307 Heat Aging of Class B Varnish Wire Enamel Systems. Heat Resistance of Insulating Varnishes. *J. R. Learn*

308 Measurement and Control of Minute Frequency Variations in Supply Systems and Survey of the Present State of the Art. *R. Leonhardt*

311 Bi-Variable Function Generation. *J. Levitt*

313 Engineering Work—The Human Resource. *C. H. Linder*

314 A Branch-Circuit Wiring System Used at the National Bureau of Standards. *R. L. Lloyd*

317 Facsimile Recording Techniques in Hydrographic Service. *Bernard Luskind*

318 An Electrical Engineering Curriculum with a Systems Philosophy. *W. A. Lynch*

320 Static Switching Systems for the Steel Industry. *R. E. Manko*

321 Four Years of Experience with High Voltage Polyethylene Power Cables. *G. Martin, P. Flouck, B. Schmidt*

322 Telemetering in Earth Satellites. *N. W. Mathews*

323 Earth Satellite Instrumentation Program. *N. W. Mathews*

324 Transformer Oil Preservation. *J. R. Meador, N. E. Dillow*

326 Compression Forces Influencing Pipe Type Cables. *E. J. Merrell, A. L. McKean*

327 Applications of Polyethylene in the Wire and Cable Industry. *E. J. Merrell*

330 The Measurement and Use of Equivalent Noise Parameters for R-F Amplifiers. *Christoph Metelmann*

CP57-331 Purchased Electric Service for a Modern Petroleum Plant. *R. W. Mills, W. R. Ankrom*

334 A Further Theoretical Analysis of the Changing of Fine Particles in a Corona Discharge. *A. T. Murphy, F. Adler, G. W. Penney*

335 Effective Appraisal of Engineers. *J. A. Newman*, Book, Allen, & Hamilton

336 The NSPE Program in the Field of Professional Ethics. *E. K. Nicholson*

337 The Use and Performance of Polyethylene Power Cable in Chemical Plants. *J. C. Norton, G. O. Wardrop*

338 Shift Register Decimal Counter. *J. A. O'Brien*

342 End Points in the Thermal Aging of Magnet Wire. *W. W. Pendleton*

229 Type *88* Loudspeaking Telephone. *E. S. Peterson*

344 Automatic Addressing for Random Access Memories. *W. W. Peterson*

345 The Operational Amplifiers as a Laboratory. *P. E. Pfeiffer*

351 Remote Stimulation of Cortical Areas in Primates. *G. C. Riggle, G. I. Johnston*

353 The Response of Resistance Dividers to Steep Front Impulse Waves. *A. F. Rohlfs, J. S. Kresge, F. A. Fisher*

352 Earth Satellite Telemetry Coding System Using Transistors and Magnetic Cores. *R. W. Rochelle*

358 Research Needed on Transmission Limitations. *F. S. Sanford*

359 Magnetic Core Event Counter for Earth Satellite Memory. *D. H. Schaefer*

362 A New 4.16-Kv, 75-Mva Air-Magnetic-Type Power Circuit Breaker in Metal-Clad Switchgear. *A. W. Simpson, L. D. Shaw*

364 The Use of Magnesium Anodes for Cathodic Protection of Gas Distribution Systems. *P. R. Skule*

366 Multicolor Storage Tube. *C. D. Bernstema, S. T. Smith, L. L. Van Hull*

368 Numerical Techniques Used in the Application of Digital Computers to Power Systems Problems. *G. W. Stagg*

369 A Flat-Bed Scanner of the Rotary-Mirror Type. *H. Stricholm, Edward Lincoln*

370 The Transistor Nor Circuit Logic and Applications. *L. F. Stringer, W. D. Rowe*

372 Effect of Wire Material on Thermal Life of Enameled Magnet Wire. *J. Thomas, J. F. Dexter*

373 A New Approach to Automatic High-Speed Grounding. *C. W. Upton, F. G. Goldner*

374 Communication and Nondestructive Read-out of Magnetic Memory Cores in Earth Satellite. *R. L. Van Allen, C. B. House*

376 Transformers Designed for Operating Conditions. *F. J. Vogel, G. W. Lengnick*

377 Development of a 50-Ampere Thyratron. *C. R. Wetter, A. M. Wohlert*

379 Engineers and Energy. *R. E. Wilson*

387 Technical and Economic Investigations in the Field of the German Electricity Supply. *Franz Lauster, George Hameister*

Solid-State Devices Conference

Courtesy Shields

SOME COMMITTEE MEMBERS for the special technical conference sponsored by the Joint AIEE-Institute of Radio Engineers Committee on Solid-State Devices and the department of electrical engineering of the Catholic University of America, April 22-23, 1957, Washington, D. C., are: *(left to right)* **J. C. Michalowicz, Catholic University, chairman; J. H. Kilcoyne, Jr., Chesapeake and Potomac Telephone Company, publicity; C. F. Pulvari, Catholic University, papers; G. E. McDuffie, Jr., Catholic University, registration; R. H. Elbourn, Bureau of Standards, finance; and I. L. Cooter, Bureau of Standards, hotel and transportation.**

COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

Communication Division

Committee on Telegraph Systems (R. B. Shanck, *Chairman;* F. W. Smith, *Vice-Chairman;* V. N. Vaughan, Jr., *Secretary*). The

Committee sponsored a Technical Session at the Fall General Meeting and another at the Winter General Meeting in which the papers presented included instances of the use of new art devices, such as transistors in switching and transmission systems. Work is going forward actively on the standardization of testing methods and performance requirements for printing telegraph equipment. It is expected that a complete draft of recommendations will be ready in the near future for consideration and comment by engineers interested in this field.

Television and Aural Broadcasting Systems Committee (C. M. Braum, *Chairman;* C. E. Smith, *Vice-Chairman;* O. W. B. Reed, Jr., *Secretary*). The principal activities of the Committee have been the procurement of papers for sessions at the General Meetings. Two sessions are planned for both the 1957 Summer and Fall General Meetings and one session is planned for the 1957 Pacific General Meeting.

In view of the wide interest being shown in the experimental five-year television teaching project now under way at Hagerstown, Md., it was decided to devote one session (with four papers) at the Summer General Meeting to this subject. Six elementary and two high schools in Hagerstown are now served via a coaxial cable system from the television studios adjacent to the Board of Education headquarters, and it is expected that all 47 schools in the city and in Washington County, Md., will be connected within two years.

Another subject receiving much attention is the research study now under way by the Television Allocations Study Organization (TASO), which began operations late in 1956. TASO, representing broadcasting and manufacturing interests, was formed at the suggestion of the Federal Communications Commission to study the technical problems and potentialities of television, particularly uhf. A member of the Committee, Dr. G. R. Town, is executive director of TASO. Four papers describing the activities of TASO will be presented at the Fall General Meeting.

One of the principal problems faced by the Committee is the relatively small number of engineers in AIEE primarily concerned with broadcasting and the resulting inadequate attendance at some of the technical sessions. Various plans are being considered to increase interest in this field in AIEE and to encourage greater attendance at the technical paper presentations.

General Applications Division

Domestic and Commercial Applications Committee (H. F. Hoebel, *Chairman;* G. E. Schall, Jr., *Vice-Chairman;* J. A. Deubel, *Secretary*). During the luncheon meeting for Committee members, which followed the technical session at the Winter General Meeting, the discussion underlined the fact that there was a continuing country-wide interest in the problems of space heating and cooling, from both power distribution and equipment manufacturers point of view.

Proposals were made and are being considered that the Committee enlarge its present activity schedule to participate in Institute sessions other than those in which the Committee is usually represented (Winter General Meeting, Pacific General Meeting, Appliance Technical Conference, and Farm Electrification Conference).

Because of the diversified duties of appliance engineers today, the Committee is actively considering incorporation, in its yearly Technical Appliance Conference Program, of speakers, papers, and discussions on subjects closely related to, but not wholly concerned with all-electric appliances—such as the application of electrical controls on gas (or other types of fuel equipment).

In this regard, there are plans to have, as speakers, members of other societies, who could present a variety of topics which would materially increase the scope of the Technical Appliance Conference Programs, thus making it more attractive to the appliance engineer, who has assumed many and varied roles during the design and manufacture of large and small electrical and electrically controlled equipment.

Committee on Marine Transportation (J. E. Jones, *Chairman;* J. D. Schuster, *Vice-Chairman;* W. N. Zippler, *Secretary*). At its October 1956 meeting in New York, N. Y., the Committee on Marine Transportation approved a number of changes to Standard No. 45 "Recommended Practice for Electrical Installations on Shipboard." Among these changes was one which dealt with extensive revisions to Section 42 on Marine Galley Equipment. This is a relatively new section in AIEE No. 45, and the present revisions are intended to improve and enlarge upon its contents. Another important action was that concerning the use of suitably applied fuses for back-up protection in switchgear and distribution circuits.

Several members of the Committee on Marine Transportation will attend meetings of Technical Committee 18 of the International Electrotechnical Commission (IEC) in Italy in May 1957. The Marine Transportation Committee is the advisory group to the United States National Committee and represents the United States in continuing efforts to standardize marine electrical practices. The first edition of IEC recommendations for "Electrical Installations on Ships" is about to be issued and present activities are directed toward reaching agreement on controversial items which could not be included in fully satisfactory form in the first edition.

The Marine Committee, continuing its bi-annual practice, is making preliminary plans for sponsoring a marine session at the 1958 AIEE Winter General Meeting.

Instrumentation Division

Indicating and Integrating Instruments Committee (J. H. Miller, *Chairman;* F. K. Harris, *Vice-Chairman;* L. J. Lunas, *Secretary*). The Indicating and Integrating Instruments Committee held a meeting during the Winter General Meeting at the Hotel Statler in New York, N. Y., attended by some 25 people. This was the first meeting of this new Committee formed under the Instrumentation Division. The Chairman reported that two sessions had been held with a wide variety of interesting papers. It was planned to hold at least one session at the Summer General Meeting in Montreal, Que., Canada.

Dr. F. K. Harris of the Bureau of Standards reported that he would start, on March 1, on a trip around the world to study the standardizing procedures in the various national laboratories of Japan, Australia, South Africa, and Europe, returning about June 15. He has agreed to give an informal paper at Montreal on his findings.

Power Division

Rotating Machinery Subcommittee (M. L. Schmidt, *Chairman;* L. O. Dorfman, *Vice-Chairman;* F. T. Carlson, *Secretary*). The Subcommittee on Single-Phase and Fractional-Horsepower Motors and the Induction Machinery Subcommittee co-sponsored a session and demonstration of the application of digital computers to the design of electric motors at the Fall General Meeting. The Induction Motor Subcommittee had a technical session at the Summer General Meeting on vibration in vertical pump motors. This problem has been of considerable concern and the papers presented useful analyses of the problem. Noise in induction motors has been of increasing interest and, although much work has been done on the problem with progress, there is still considerable work necessary.

The D-C Machinery Subcommittee has been active on Test Code and Guide Work. Code 501, "Test Code for D-C Machines," has been revised to date. Also the "Guide for Determination of Short Circuit Characteristics of Direct Current Machinery" has been completed. This Subcommittee has also been requested by the Power Generation Committee to prepare a "Guide for Operation and Maintenance of Direct Connected Turbine-Generator Exciters."

The Synchronous Machinery Subcommittee has been quite active on Test Code and Guide work also. The "Guide for Operation and Maintenance of Turbine Generators" was approved by letter ballot and will be issued for trial use in the near future.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus and Systems,* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

"Synchronous Machinery Test Code 505," has reached the stage where an assembly of a complete draft will soon be issued and it is hoped that the revised code can then be issued without much delay. "American Standard Definitions for Electrical Terms" have been approved by letter ballot and were submitted to the C42 Subcommittee for inclusion in its forthcoming edition.

The Insulation Subcommittee is very active on several situations such as "High Voltage D-C Testing of Rotating Machines." Work is in progress on the revision of AIEE No. 43 on "Recommended Practices for Testing Insulation Resistance of Rotating Machinery." Progress also has been made on "Dielectric Acceptance Test for High Voltage Stator Windings of New Rotating Machinery, Rated 6,000 Volts and above, Using D-C Test Voltages." Much of the new data now appears in American Standard *C50* No. 2.

AIEE PERSONALITIES

Nominated for Institute President

W. J. Barrett (M '36, F '50), transmission maintenance engineer, New Jersey Bell Telephone Company, has been nominated for the office of 1957-58 President of the AIEE. Mr. Barrett was born in Brooklyn, N. Y., January 10, 1899. He received the E.E. degree *cum laude* from The Polytechnic Institute of Brooklyn in 1920. Since graduation, he has been employed continuously in engineering work in the Bell System. At first, he was in the operation and engineering department of the American Telephone & Telegraph Company; later, with the Ohio Bell Telephone Company; and, since 1930, with the New Jersey Bell Telephone Company. The greater part of his work has been

Courtesy Pach Bros., N. Y.

W. J. Barrett

in the field of co-ordination of power and communication systems. Mr. Barrett is a licensed professional engineer in the State of New Jersey, a member of the National Society of Professional Engineers, and of Tau Beta Pi. He has been an active and constructive participant in civic affairs in his home community, Glen Ridge, N. J. Mr. Barrett has served on the AIEE Board of Directors since 1949, and has been treasurer of the Institute since 1953. He has served on the following AIEE Committees: Sections (1948-50); Finance (1949-52, chairman 1950-52); Communication Division (1950-53); Lamme Medal (1950-53); Planning and Co-ordination (1950-56); Headquarters (1950-53); Executive (1950-57); Joint AIEE-Institute of Radio Engineers (IRE) Co-ordination Committee (1951-55, chairman 1953-55); Board of Trustees, United Engineering Trustees, Inc. (1951-57, president 1955-56); Board of Examiners (1952-53); Engineers Joint Council representative (1950-56); Engineering Foundation Board (1955-56); Engineering Societies Library (1955-56); AIEE Retirement System (1950-56). Mr. Barrett has also served as secretary of District No. 3, 1948-49; New York Section secretary, 1945-46; and New York Section chairman, 1947-48).

Nominated for Institute Vice-Presidents

B. R. Teare, Jr. (AM '29, F '42), dean of Engineering and Science, Carnegie Institute of Technology, Pittsburgh, Pa., has been nominated for the office of vice-president of Middle Eastern District No. 2. Born in Menomonie, Wis., Dr. Teare received his bachelor's and master's degrees from the University of Wisconsin. In 1929, he joined the General Electric Company as a student in the advanced engineering course. In 1931, he became supervisor of the electrical engineering section of the course. In 1933, he joined the faculty of Yale University. While serving as instructor, then assistant professor of electrical engineering, he received his D. Eng. degree in 1937. Dr. Teare joined the faculty of Carnegie Institute of Technology in 1939 and was named Buhl Professor of electrical engineering in 1943. He was appointed dean of Graduate Studies in 1950, and dean of the College of Engineering and Science in 1952. In 1947, he received the George Washington Award from the American Society for Engineering Education. He is a fellow of the Institute of Radio Engineers, and a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Phi Kappa Phi. Dr. Teare has served on the following AIEE Committees: Communication (1934-36); Electrical Machinery (1937-42); Education (1941-57, chairman 1948-50); Professional Group Co-ordinating Committee (1948-50); Publication (1948-50); Edison Medal (1951-56) and Professional Development and Recognition Department (1956-57). Currently he is vice-chairman for Region III of the Education and Accrediting Committee of the Engineers' Council for Professional Development. He has been active in the AIEE Pittsburgh Section serving on many committees and as chairman, 1953-54.

H. W. Oetinger (AM '18, F '52, Member for Life), executive assistant, Duke Power Company, Charlotte, N. C., has been nominated for the office of AIEE vice-president for Southern District No. 4. Mr. Oetinger was born in Philadelphia, Pa., October 10, 1894. He was graduated in 1915 with the degree of B.S. in E.E. from the University of Pennsylvania, where he was elected a member of Sigma Xi. After graduation, he spent two years on the test course of the General Electric Company in Schenectady, N. Y., and Pittsfield, Mass. In 1917, he was transferred to the New York, N. Y., office as field engineer. During World War I, he served as a naval aviator with a commission as ensign. He returned to the New York office of General Electric in 1919 and remained until 1926, when he went to the General Engineering and Management Corporation on a one-year leave of absence. In 1927, he accepted a position as assistant to the vice-president and general manager of the Duke Power Company. During World War II, he served as deputy administrator for the Utilities Division of the Mecklenburg County Council for Civil Defense. During the Korean conflict, he was chairman of the Virginia-Carlinas Co-ordinating Committee for the Defense Electric Power Administration. At present, he is serving as chairman of the Subcommittee for Atomic Power on the North Carolina Governor's Advisory Committee, chairman of the Power Co-ordination Committee of the Southeastern Electric Exchange, and represents the Virginia-Carolinas group as area representative on the Power Survey Committee of the Edison Electric Institute. He is also a member of the North Carolina State Advisory Committee on Scientific Engineering and Specialized Personnel for the State director of selective service. Mr. Oetinger has recently agreed to accept an appointment by the Secretary of the Interior Department as director of power supply for defense area No. 4 which includes most of the southeastern states. He has served AIEE as co-general chairman, Asheville District Meeting in 1946, District vice-chairman of the Membership Committee in 1947, and chairman of the North Carolina Section in 1954. He is the incumbent District secretary. Mr. Oetinger has served on the following AIEE Committees: Membership (1947-48), and Management (1953-57).

A. G. Johnson (M '49), chief engineer, Omaha Public Power District, Omaha, Nebr., has been nominated for the office of vice-president of North Central District No. 6. Mr. Johnson was born in Albert City, Iowa, January 13, 1902. He was graduated from Iowa State College in 1928 with a B.S. degree in E.E. After graduation, he was employed by the Nebraska Power Company, now Omaha Public Power District, in the overhead line department. In 1938, he was made supervisor of the underground engineering department of the Engineering Division and assumed responsibility for development of the underground a-c 13.8 kv network system in the City of Omaha, Nebr. He was appointed assistant chief engineer in 1949, and chief engineer in 1951. Mr. Johnson is a member of the Omaha Engineers Club, Nebraska Engineering Society, and Omaha Chamber of Commerce. He is a registered professional engineer in the State of Nebraska.

B. R. Teare, Jr.

Photography by Augier's

H. W. Oetinger

A. G. Johnson

Courtesy Mouin Studios

O. A. Gustafson

Mr. Johnson has been an active member of the AIEE Nebraska Section, serving as Executive Committee member, 1950-51; secretary, 1951-52; vice-chairman, 1952-53; and chairman, 1953-54.

O. A. Gustafson (AM '25, M '42), manager, installation and service engineering, Pacific Northwest District, General Electric Company, San Francisco, Calif., has been nominated for the office of vice-president of Pacific District No. 8. Mr. Gustafson was born October 31, 1898, in Little Falls, Minn. He graduated from the University of Idaho in 1923 with a B.S. degree in E.E. After graduation, he joined the General Electric Company and participated in the test course in Schenectady, N. Y. In 1924, he became a member of the a-c engineering design group and in 1926 went into the central station engineering department in Schenectady. Mr. Gustafson transferred to the Los Angeles, Calif., office in 1928 as central station engineer—application. In 1940, he was made district central station and transportation engineer in Los Angeles and about two years later transferred to the San Francisco, Calif., office in this same capacity. In 1944, he was made assistant Pacific District engineer and became Pacific District engineer in 1945. Mr. Gustafson was chairman, AIEE San Francisco Section, 1948-49, and served as chairman, Sports Activities Committee, Summer and Pacific General Meeting in San Francisco, Calif., June 1956.

G. F. Tracy (AM '26, M '46), professor and head of the electrical engineering department, University of Toronto, has been nominated for the office of vice-president of Canada District No. 10. Prof. Tracy was born in Toronto, Ont., Canada, February 2, 1896. He graduated from the University of Toronto in 1921 with a B.S. degree in E.E. In 1926, he received an M.S. degree from the Massachusetts Institute of Technology. He served as research assistant, department of electrical engineering, University of Toronto, from 1921 to 1924. In 1925, he went to the University of Wisconsin as an instructor in the electrical engineering department. He returned to the University of Toronto as assistant professor in 1928. He was made associate professor in 1937, professor and chairman of the electrical engineering department in 1945, and head of the department in 1947. Prof. Tracy is a member of the American Society for Engineering Education, and Tau Beta Pi. He is a registered professional engineer in the province of Ontario and the author of several technical articles. Prof. Tracy has served as secretary-treasurer and chairman of the Madison, Wis., Section of the AIEE. He has been a member of the Executive Committee of the Toronto Section since 1950 and served as chairman of that Section. 1955-56. Prof. Tracy has served on the AIEE Committee on Education (1948-57).

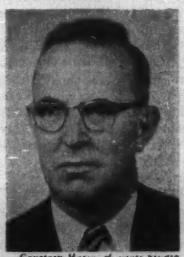
Nominated for Institute Directorships

W. R. Clark (AM '37, M '44), chief engineer, product engineering department, Leeds and Northrup Company, Philadelphia, Pa., has been nominated to serve on the AIEE Board of Directors. Dr. Clark was born in Trainer, Pa., November 28, 1907. He received a B.S. degree in E.E. from the Moore School of the University of Pennsylvania in 1929. In July 1929, he was employed by Leeds and Northrup Company in the research department. In October 1931, he returned to the University of Pennsylvania and obtained an M.S. degree in E.E. In June of the following year, he became associated with the Franklin Institute Museum Staff taking charge of the Electricity and Magnetism Section of the physics department. In 1934, he returned to the Leeds and Northrup Company as an electrical research engineer and, in 1938 while still with Leeds and Northrup, he received a doctor of science degree in E.E. from the University of Pennsylvania. In 1945, he became supervisory research technologist of the company, and in 1952 was appointed chief of the Electrical Division of the research department. In 1955, he was named chief of the Electro-Mechanical Division of the research and development department. In April 1956, he was appointed assistant chief engineer and in July 1956 became chief engineer of the product engineering department. He served for several years on the Panel on Test Equipment of the Research and Development Board of the United States Military Establishment. Dr. Clark is a senior member of the Institute of Radio Engineers, a member of the Franklin Institute, the Instrument Society of America, and the Engineers Club of Philadelphia. He was a member of the Board of Managers of the AIEE Philadelphia Section, 1943-45; secretary, 1945-47; and chairman, 1947-48. Dr. Clark has served on the following AIEE Committees: Electronics (1945-55); Instruments and Measurements (1947-55, chairman 1949-51); Technical Program (1949-50); Standards (1949-50); Science and Electronics Division (1949-57, chairman 1952-54); Technical Operations (1952-57,

Fox Lake Studio

G. F. Tracy

W. R. Clark



Courtesy Morris Elements Studios

E. W. Morris

J. C. Strasbourger

chairman 1956-57); Instrumentation Division (1956-57); Recording and Controlling Instruments (1956-57); and Planning and Co-ordination (1956-57).

E. W. Morris (AM '29, F '48), manager, South Pacific District Engineering and Service Division, Westinghouse Electric Corporation, has been nominated to serve on the AIEE Board of Directors. Mr. Morris was born in Blue Springs, Nebr., February 4, 1903. He graduated from the University of Nebraska in 1925, and joined the Westinghouse Electric Corporation in March of that year in the graduate student training course. Upon completion of the course, he became associated with the design of switchgear and large power oil circuit breakers. In 1925, he was transferred to the company's district engineering department on the Pacific Coast, being located at various times in the Los Angeles and San Francisco, Calif., offices. His activities during district engineering assignments included the application of electrical equipment in various industrial plants, such as rubber mills, steel mills, motion picture studios, and aircraft factories. Following several years of industrial activity, he became district electric utility engineer. In 1942, he was named manager of the South Pacific District Engineering and Service Division for the company. In this position, which he holds at the present time, he is responsible for the engineering work related to the application of all mechanical, electrical, and electronic devices manufactured by Westinghouse and used by industries located in southern California, southern Nevada, and Arizona, together with the servicing, installation, and repair of this apparatus. Mr. Morris has been active in the affairs of the Los Angeles and San Francisco Sections for 27 years, having served on many Section committees, and as chairman of the Los Angeles Section, 1946-47. He has served on the following AIEE Committees: Membership (1946-47, 1948-55); and Education (1950-54).

J. C. Strasbourger (AM '31, M '40), general supervisor, mechanical buying, Cleveland Electric Illuminating Company, has been nominated to serve on the AIEE Board of Directors. Mr. Strasbourger was born in Cleveland, Ohio, December 22, 1906. He was graduated from the University of Cleveland in 1929 with a degree in E.E., and acquired his LL.B. degree in 1934 from the Cleveland Law School. Mr. Strasbourger became associated with the Cleveland Electric Illuminating Company in 1929, and began his work there as an electrical engineer. He has worked in relay testing and field engineering, system operation, and procurement and mechanization. He is a member of the Cleveland Engineering Society and the Engineers Club of New York. Mr. Strasbourger is a former vice-president of AIEE District No. 2 and has served on the following AIEE Committees: Planning and Co-ordination (1946-49, 1954-57); Sections (1947-50, 1951-55, chairman 1947-49); Committee on Award of Institute Prizes (1948-49); and Safety (1950-51). He was a director of District No. 11, 1955-56, and was named chairman of the AIEE Administration Department, (1956-57).

Nominated for Institute Treasurer

L. F. Hickernell (AM '25, F '34), chief engineer, Anaconda Wire & Cable Company, Hastings on Hudson, N. Y., has been nominated for the office of treasurer of the AIEE. Mr. Hickernell was born in Middletown, Pa., March 22, 1899. He received a B.A. degree from Grinnell College in 1920 and a B.S. degree in E.E. from Massachusetts Institute of Technology in 1922. Upon graduation, he joined the graduate student engineer course of the General Electric Com-

L. F. Hickernell

pany, Lynn, Mass. In 1923, he entered the engineering department of the Consumers Power Company, Jackson, Mich. The following year he became assistant investigations engineer of the successor company, the Commonwealth Power Corporation of Michigan. He became general engineer in the electrical engineering department in 1927. Stevens and Wood, Inc., succeeded this company in 1929 and, in 1930, this concern was in turn succeeded by Allied Engineers, Inc. Mr. Hickernell continued as general engineer with these firms. In 1931, he joined Anaconda Wire and Cable Company, becoming chief engineer in 1933. He has served on many committees of the National Electric Light Association, the American Society for Testing Materials, National Research Council, and the Insulated Power Cable Engineers. Mr. Hickernell has served on the following Institute Committees: Electrical Machinery (1929-33); Protective Devices (1929-32); Power Transmission and Distribution (1930-42, 1945-47); Publication (1934-35, 1951-54); Board of Examiners (1941-57); Insulated Conductors (1947-57, chairman 1947-49); Public Relations (1952-54); Standards (1947-49); Technical Program (1947-50); Power Division (1947-53, chairman 1949-51); Planning and Co-ordination (1949-50, 1952-57, chairman 1954-57); Award of Institute Prizes (1949-50); Technical Operation (1950-57, chairman 1951-54); Engineers Joint Council alternate (1954-57); Executive (1954-57); and Edison Medal (1954-56). He has served on the AIEE Board of Directors since 1953.

R. H. Barclay (AM '14, F '28, Member for Life), vice-president, engineering, J. G. White Engineering Corporation, New York, N. Y., is now practicing independently as a consulting engineer. He also has been retained by J. G. White as consultant. Mr. Barclay was born in St. Louis, Mo., August 10, 1887, and attended Washington University. He spent the early part of his career working for electrical companies in Missouri. In 1915, he joined the Brooklyn-Manhattan Transit Corporation as assistant electrical engineer. From 1917 to 1922, Mr. Barclay was employed as chief electrical engineer for The Foundation Company, New York, N. Y., where he was responsible for the electrical engineering and electrical construction of a large number of loading plants, shipyards, and vessels. After associations with Starrett and Van Vleck, architects, New York, N. Y., the Stone and Webster Corporation, Boston, Mass., and McClelland Barclay Art Products, Inc., New York, N. Y., he was appointed to the Federal Power Commission in 1934. Four years later, he was expert adviser to the Joint Committee on Investigation of the Tennessee Valley Authority (TVA) on matters relating to the design, construction, operation, and integration of the power generating facilities of the TVA. He joined the J. G. White Engineering Corporation in 1941 as electrical engineer in charge of the Electrical Engineering Division. He became engineering manager in 1950, and vice-president in charge of engineering in 1953. Mr. Barclay has been a member of the Board of the Engineering Societies Library (1942-48, chairman 1946-48) and has served on Engineers' Council for Professional Development (1950-56). He has been serving on the AIEE Board of Examiners from 1943 to the present time, acting as chairman from 1946-48. He was a member of the AIEE Marine Committee (1918-19).

S. W. Marras (AM '52), secretary, Electrical Section, Association of American Railroads, Chicago, Ill., has been appointed secretary and general manager of United Engineering Trustees, Inc. Mr. Marras was born in Huron, S. Dak., May 22, 1921. He received a B.S. degree in E.E. from the University of Illinois in 1949. After graduation, he joined the Illinois Central Railroad as a junior engineering aid. In 1952, he became secretary of the Electrical Section, Association of American Railroads. In this position, he functioned as executive officer of the Electrical Section and handled matters pertaining to all electrical, design, maintenance, engineering, and procedure for the Canadian and American Railroads. Mr. Marras has been a member of the AIEE Land Transportation Committee since 1952.

Hans Schiller (M '45), assistant plant manager of the Perth Amboy Plant of the General Cable Corporation has been appointed manager of the Telephone Plant at Perth Amboy, N. J. This plant was formed by dividing the manufacturing facilities at Perth Amboy into three separate plants, one of which comprises the facilities for producing telephone cables. Dr. Schiller received his Ph.D. degree in physics from the University of Vienna, Austria, in 1922. He was an assistant at the department of physics until 1927, doing research work in the field of physical chemistry and electrophysics, particularly in connection with the electrical conductivity of dielectrics at high field strengths. In 1927, he joined the

Sueddeutsche Kabelwerke in Mannheim, Germany, where he became manager in charge of production and research in 1932. He also published numerous papers in the field of high voltage and communication cables. Since 1936, he has been connected with the General Cable Corporation where he worked in various functions in the central offices and production plants. Since 1954, he has been assistant plant manager at Perth Amboy in charge of telephone cable production.

T. J. Dunsheath (AM '49), senior engineer, Automatic Control System Section, Cook Research Laboratories, a division of Cook Electric Company, Chicago, Ill., has been promoted to the position of technical director of the section. Following graduation from Illinois Institute of Technology in 1943 with a B.S. degree in mechanical engineering, Mr. Dunsheath served as an electronic technician with the U. S. Navy. In 1949, he received an M.S. degree in E.E. from Northwestern University. While working for his degree, he was an assistant instructor in electrical engineering. He was associated with Magnaflux Corporation, Chicago, Ill., for four years in the successive positions of design engineer, research engineer, and assistant chief engineer. He joined Cook Research Laboratories in May 1951. Mr. Dunsheath is a member of Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Pi Tau Sigma.

J. E. Kearns (AM '52), application engineering department, The Bristol Company, Waterbury, Conn., has been appointed manager of a new district sales office in San Francisco, Calif. Graduated from the Massachusetts Institute of Technology in 1932 with a B.S. degree in E.E., he was first associated with the General Electric Company in the test and engineering departments. Later, he was an instructor in electrical engineering at the Bridgeport (Conn.) Engineering Institute. He has been with Bristol since 1936. He has served at the company's New York, N. Y., Birmingham, Ala., and New Orleans, La., offices. For the past four years he has been in the application engineering department specializing in automatic control. Mr. Kearns is a member of the Instrument Society of America.

L. M. Rodgers (AM '36, M '47), project engineer, Research Division, Philco Corporation, has joined the Automatic Signal Division, Eastern Industries, Inc., East Norwalk, Conn., as research assistant to the vice-president—general manager. Mr. Rodgers received the E.E. degree from Rensselaer Polytechnic Institute in 1935. For the 15 years prior to joining Eastern Industries, he was with the Philco Corporation in various capacities in the Research and Patent Divisions. In 1952, Mr. Rodgers founded the Citizen's Committee on Traffic Control, an engineering advisory group to the traffic engineering department in Philadelphia, Pa., and was chairman of this organization for several years. He has also served as chairman of the Transportation Committee of the Philadelphia Citizen's Council on City Planning. He has been chairman of the AIEE Philadelphia Section Electronics Discussion Group and a manager of that Section. A registered professional engineer in the State of Pennsylvania, Mr. Rodgers is a member of the Institute of Radio Engineers, the National Society of Professional Engineers, and the Pennsylvania Society of Professional Engineers. Mr. Rodgers has served on the following AIEE Committees: Television and Aural Broadcasting (1949-56) and Instruments and Measurements (1950-51).

M. S. Waller (AM '46), assistant superintendent of engineering, Automatic Electric Company, Chicago, Ill., has been named superintendent of engineering. Mr. Waller, who received his bachelor's degree in physics and mathematics, and his master's degree in business administration at the University of Chicago, has been with Automatic Electric since 1940. During that time he has held a succession of engineering and technical positions, including assignments in quality control and engineering, as staff engineer in the research and development laboratories and later in the commercial department, as production co-ordinator, as supervisor of engineering planning and scheduling, and as assistant superintendent of engineering, the position he held prior to his new assignment. During World War II, Mr. Waller served as a Signal Corps radar officer, assigned to the U. S. Air Force. He is a registered professional engineer in the State of Illinois.

OBITUARIES

Harry Stephen Bueche (AM '33, M '47), associate professor of electrical engineering, University of Delaware, died recently at the age of 59. Born in Steubenville, Ohio, Mr. Bueche received a B.S. degree from the U. S. Naval Academy in 1920, a bachelor's degree in E.E. from Villanova College in 1922, and an E.E. degree from Villanova in 1925, and an M.S. degree in E.E. from Iowa State College in 1930. He was employed by Consolidated Edison Corporation of New York and Follansbee Brothers Steel Company before he entered the field of teaching. He joined the faculty of Kansas State College in 1925 as an instructor, later becoming assistant professor. From 1933 to 1947, he was professor and head of the electrical engineering department at Villanova College. He taught at Drexel Institute of Technology and Temple University during the summers of the years 1941 through 1948. He joined the faculty of the University of Delaware in 1947. Mr. Bueche also was consultant to several engineering firms in the Newark, Del., area. He was a member of Sigma Tau, Tau Beta Pi, the American Society for Engineering Education, the Naval Academy Alumni Association, the American Association of University Professors, and the Institute of Radio Engineers. Mr. Bueche was a trustee of the Delaware Bay Section of the AIEE, and had served as counselor of several AIEE Student Branches.

Samuel Warren Andrews (AM '14, M '20, Member for Life), president, H. G. Acres & Company, Limited, consulting engineers, Niagara Falls, Ont., Canada, died recently. Mr. Andrews was born at Lead, S. Dak., on September 24, 1890. In 1912, he received the degree of mechanical engineer from Cornell University. His early experience was obtained in the employ of the Southern Pacific Railway. Later he joined the engineering department of the Hydro-Electric Power Commission of Ontario, where he worked on a number of projects. He was the electrical engineer during the building of the London and Port Stanley Railway, one of the H.E.P.C. projects. Afterwards, he was the plant engineer during the construction of the Chippawa power canal and the Sir Adam Beck No. 1 Generating Station. In 1926, he joined the firm of H. G. Acres & Company Limited, serving as chief engineer of that organization from 1930 to 1945, and president of the company from 1945 until his death. During that time, he was actively engaged on many generating station projects. He was also very active in the steam and electrical developments at various paper mills and in the extension of the Toronto Waterworks System. As well as being president of H. G. Acres & Company Limited, he was a director of The Fluor Corporation of Canada Limited and of The Fluor Corporation Limited of Los Angeles, Calif. He was also president of Canadian Overseas Projects Limited, a registered professional engineer of the Province of Ontario, a member of the American Society of Mechanical Engineers, a member of the American Waterworks Association and a member of the American Society for Testing Materials.

Clifford Ray Beardsley (AM '08, M '20, F '30, Member for Life), retired electrical engineer, died recently. Mr. Beardsley was born in Bridgeport, Conn., December 19, 1885. He was graduated from the Sheffield Scientific School, Yale University, in 1905 with a Ph.B. degree in E.E. Mr. Beardsley joined the General Electric Company in 1905, remaining until 1911 when he was employed by the United Illuminating Company, Bridgeport, Conn. From 1918 to 1923, he was with Fred T. Ley and Company as electrical engineer in charge of design and construction of power and industrial plants. In 1923, he joined the Brooklyn Edison Company and became affiliated with the Consolidated Edison Company of N. Y., Inc., when the two companies were merged in 1937. At the time of his retirement in 1951, he was director of economic and industrial development. Mr. Beardsley was a very active member of the Institute, having served on the following AIEE Committees: Edison Medal (1937-41); Legislation Affecting the Engineering Profession (1937-41, chairman 1939-41); Technical Program (1937-40); Special Committee on ECPD Recommendations (June-October 1937); Special Committee on Model Registration Law (chairman 1937-39); Institute Policy (1940-42, chairman 1941-42); Special Committee on Registration of Engineers (chairman 1942-46); Code of Principles of Professional Conduct (1942-43); Advisory Board of National Bureau of Engineering Registration (1942-45); Members-for-Life Fund (1944-51, chairman 1947-50); and Board of Examiners (1950-51). He also served on the Board of Directors (1937-41).

Presley Alonzo Williams (AM '52), design engineer in charge of the design department, Nashville Electric Service, died recently. Mr. Williams was born in Nashville, Tenn., and

was graduated from Vanderbilt University in 1933 with a B.S. degree in E.E. He had been an employee of Nashville Electric and its predecessor company since April 21, 1934. He was promoted to the position of design engineer in charge of the Design Section of the engineering department on March 15, 1956, having previously served as assistant design engineer. He served in World War II being commissioned first lieutenant in the Army Signal Corps in 1942. He served in both Okinawa and Korea and was discharged in May 1946 with a captain's rating. Mr. Williams was very active in the Nashville Section, AIEE and was also a member of the National Society of Professional Engineers and the Tennessee Society of Professional Engineers.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of February 21, 1957, recommended the following applications for transfer. Any objections to these transfer should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Althouse, K. L., asst. to supervisor operation instruction, Pennsylvania Pr. & Lt. Co., Hazleton, Pa.

Anders, R. D., engineer, Philadelphia Electric Co., Philadelphia, Pa.

Barefield, R. J., Birmingham division engineer, Southern Bell Tel. & Tel. Co., Birmingham, Ala.

Beck, O. R., vice-president, W. Vance Middough & Associates, Cleveland, Ohio.

Becker, J. A., supervisor, carrier apparatus design engg., Westinghouse Electric Corp., Halethorpe, Md.

Belcher, T. H., executive staff supervisor, Michigan Bell Tel. Co., Detroit, Mich.

Benner, W., research assoc. engineer, Willow Run Labs., University of Michigan, Ypsilanti, Mich.

Borst, D. W., application engineer, General Electric Co., West Lynn, Mass.

Braun, C. M., engineering consultant, Joint Council on Educational TV, Washington, D. C.

Brown, H. H., president, Sachs Electric Co. of Illinois, East St. Louis, Ill.

Carnes, E. C., electrical engineer, Aerojet General Corp., Neosho, Mo.

Cartin, T. J., engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.

Cerda Echaurren, H., chief engineer, Banco del Estado de Chile, Santiago, Chile.

Christmann, E. R., application engineer, Westinghouse Electric Corp., St. Louis, Mo.

Cregar, C. J., chief test engineer, Georgia Power Co., Atlanta, Ga.

Douglass, T. F., division manager, Public Service Co. of New Mexico, Belen, N. M.

Drake, R. K., manager, laboratory administration, General Electric Co., Fort Wayne, Ind.

Duncan, C. C., asst. director of operations, American Tel. & Tel. Co., New York, N. Y.

Gee, R. O., manager of service, Reliance Electric & Engineering Co., Cleveland, Ohio.

Gens, H. J., patent lawyer, U. S. Atomic Energy Commission, Lemont, Ill.

Goeser, J. A., electrical engineer, Central Pr. & Lt. Co., Corpus Christi, Tex.

Green, J. N., electrical engineer, Metropolitan Edison Co., Reading, Pa.

Grove, J. F., associate professor of electrical engineering, University of Rhode Island, Kingston, R. I.

Gulick, H. E., asst. general manager, public service dept., City of Glendale, Calif.

Harford, G. P., transmission design engineer, Rhode Island, New England Tel. & Tel. Co., Providence, R. I.

Heagerty, J. J., application engineer, General Electric Co., Schenectady, N. Y.

Hirtler, R. W., relay design engineer, water & power dept., City of Los Angeles, Calif.

Hoagland, A. S., project engineer, International Business Machines Corp., San Jose, Calif.

Hoffman, G. M., chief electrical engineer, Mogan Engineering Co., Alliance, Ohio.

Hoke, T. R., electrical engineer, Oklahoma Gas & Electric Co., Oklahoma City, Okla.

Holmquist, A. S., superintendent of electrical transmission & distribution, Ohio Edison Co., Massillon, Ohio.

Huff, C. L., design engineer, E. P. McLean Engineering Co., Moultrie, Ga.

Jacox, W. R., patent attorney, Dybvig & Jacox, Dayton, Ohio.

Johnson, H. E., engineer, General Electric Co., Pittsfield, Mass.

Karlsson, E. E., chief engineer, General Tel. Co. of the Southwest, San Angelo, Tex.

Kent, N. S., assistant to assistant chief engineer, British Columbia Electric Co., Vancouver, B. C., Canada.

MacMorris, P. D., traffic engineer, The Chesapeake & Potomac Tel. Co., Washington, D. C.

Madsen, E., assistant to superintendent of substations, B. C. Electric Co., Ltd., Vancouver, B. C., Canada.

Mark, D. G., principal electrical engineer, Battelle Memorial Institute, Columbus, Ohio.

Marshall, A. L., system dispatcher, Narragansett Electric Co., Providence, R. I.

McArthur, B. E., vice-president in charge of engineering, Magnethermic Corp., Youngstown, Ohio.

McBrearty, J. J., industrial supervisor, Schuylkill Div., Pennsylvania Pr. & Lt. Co., Pottsville, Pa.

McClellan, C. E., project manager, Westinghouse Electric Corp., Baltimore, Md.

McKibben, G. M., president, Green Mountain Power Corp., Burlington, Vt.

Meining, R. M., electrical designer, The Detroit Edison Co., Detroit, Mich.

Moore, G. J., electrical engineer, Black & Veatch, C. E., Kansas City, Mo.

Moore, W. J. M., associate research officer, National Research Council, Ottawa, Ont., Canada.

Morgan, M., project engineer, International Business Machines Corp., Endicott, N. Y.

Morison, D. P., engineering assistant, British Columbia Tel. Co., Vancouver, B. C., Canada.

Mortimer, E. S., manager of operations, Eastern Shore Public Services Co., Salisbury, Md.

Neubauer, J. R., manager, communications system engg., Radio Corp. of America, Camden, N. J.

Pettinos, J. W., Jr., meter engineer, City Public Service Board, San Antonio, Tex.

Pierce, J. L., insulation development engineer, General Electric Co., Pittsfield, Mass.

Pravda, M. F., supervisor, advance reactor design, General Electric Co., Knolls Atomic Power Lab., Schenectady, N. Y.

Richmond, R. B., engineer, General Radio Co., Cambridge, Mass.

Saxon, A. N., manager, Graybar Electric Co., Inc., Corpus Christi, Tex.

Schultz, F. W., manager, electrical dept., Fairbanks, Morse & Co., Los Angeles, Calif.

Seymour, A. M., manager, technical services, Lenkurt Electric Co., San Carlos, Calif.

Shields, W. B., electrical engineer, Gilbert Associates, Inc., New York, N. Y.

Smith, W. W., assistant chief engineer, New Jersey Bell Tel. Co., Newark, N. J.

Spriggs, E. W., service superintendent, Otis Elevator Co., Chicago, Ill.

Stallings, H. B., manager, electro clutch sales, I-T-E Circuit Breaker Co., Philadelphia, Pa.

Steffen, G. W., division distribution engineer, Ohio Edison Co., Massillon, Ohio.

Uthlaut, H. T., Jr., engineer, Southern Bell Tel. & Tel. Co., Birmingham, Ala.

Vermeulen, W., manager, accessory equipment dept., General Electric Co., Bridgeport, Conn.

Weber, L. A., member of technical staff, Bell Telephone Labs., New York, N. Y.

66 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before April 25, 1957, or June 25, 1957, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Appel, H. J., staff engineer, Socony Mobil Oil Co., Inc., New York, N. Y.

Armington, R. L., assistant electrical engineer, Boston & Maine R.R., Boston, Mass.

Beckham, C. L., engineer (aviation communications), American Tel. & Tel. Co., New York, N. Y.

Boyd, R. L., development engineer, Electromode Div., Commercial Controls Corp., Rochester, N. Y.

Brosseau, R. B., vice-president, Northeastern Development Ltd., Montreal, Que., Canada.

Brown, E. H., assistant engineer, Office of Electrical Engineer, Pennsylvania Railroad, Philadelphia, Pa.

Caldwell, W. H., electrical engineer, International Resistance Co., Philadelphia, Pa.

Coles, R. S., project engineer, Hydro Electric Power Commission of Ontrio, Toronto, Ont., Canada.

Douthit, J. C., assistant professor, Arizona State College, Tempe, Ariz.

Eggleston, R. B., application engineer, General Electric Co., Schenectady, N. Y.

Foster, H. G., managing editor, *Electronic Engineering & Electrical Energy*, London, England.

Hagerty, G. E., engineering manager, Westinghouse Broadcasting Co., Inc., New York, N. Y.

Harris, C. H., projects manager & Dty C/E of the G. E. Co. of Indian Private Ltd., Calcutta, India.

Henderson, J. T., National Research Council, Ottawa, Ontario, Canada.

Hilbert, E. A., (re-election), fusion power study engineer, General Electric Co., Schenectady, N. Y.

Hinderer, G. E., project engineer, Westinghouse Electric Corp., Baltimore, Md.

Hogland, V. W., senior engineer, Burns & McDonnell Engg., Kansas City, Missouri.

Horn, T. R., instructor, Penn State U Center, York, Pa.

Husock, B., vice-president, engineering, Harco Corp., Cleveland, Ohio.

Johnson, L. B., general department manager, Lenkurt Electric Co., San Carlos, Calif.

Jones, L. G. F., advisory engineer, Westinghouse Electric Co. (Air Arm Div.), Baltimore, Md.

Levitt, A. A., assistant manager, Hi-Voltage Equipment Co., Cleveland, Ohio.

Light, F. H., senior engineer, Philadelphia Electric Co., Philadelphia, Pa.

Lovell, C. A., director of switching, Systems Development, Bell Telephone Labs., Inc., New York, N. Y.

Martin, S., Jr., manager, Power Rectifier & D-C Equipment Sales, General Electric Co., Philadelphia, Pa.

McClung, R., electrical maintenance superintendent, P. Ballantine & Sons, Newark, N. J.

Medlar, J. L., consulting electrical engineer, Medlar Electric Co., Reading, Pa.

Moreton, A. G., retired engineer, General Electric Co., Erie, Pa.

Palmer, L. N., district engineer, Southern Bell Tel. & Tel. Co., Jackson, Miss.

Poch, A., chief engineer, Compania Chilena de Electricidad, Santiago, Chile, S. A.

Ranftl, R. M., head, Product Engineering Department, Airborne Systems Labs., Hughes Aircraft Co., Culver City, Calif.

Smith, R. W., senior engineer, West Penn Power Co., Greensburg, Pa.

Sziklai, G. C., assistant to vice-president, Westinghouse Elec., Elmira, N. Y.

Tarbell, J. H., industrial engineer, Kansas City Power & Light Co., Kansas City, Mo.

Trilsch, J. D., Trilsch Corp., Houston, Texas.

Vradenburgh, R., manager of engineering, Ward Leonard Electric Co., Mt. Vernon, N. Y.

Wagner, R. P., electrical engineer, Stone & Webster, Yorktown, Va.

Wallman, O. F., engineer, American Tel. & Tel. Co., New York, N. Y.

Williams, E. M., principal electrical engineer, The Fluor Corp. Ltd., Los Angeles, Calif.

Williams, G., Jr., assistant to the director of power operations, T. V. A., Chattanooga, Tenn.

Young, J. W., lighting engineer, New England Power Service, Boston, Mass.

41 to grade of Member

ELECTRICAL ENGINEERING EDUCATION

AIEE in Swarthmore College

ENGINEERING has been included in Swarthmore's curriculum since the founding of the College in 1864. At present, two of the campus buildings, Hicks and Beardsley Halls, are devoted to engineering. The Engineering Division consists of three departments—electrical, mechanical, and civil—with a total of 12 faculty members. About 100 students are enrolled in the division, preparing for the degree of bachelor of science in one of these engineering fields.

The AIEE Student Branch was founded in 1921 under the leadership of Sherman McAllister, chairman, and Elsa Palmer, secretary. Miss Palmer is now the wife of Prof. H. M. Jenkins, chairman of the electrical engineering department. In 1955, the Branch was made a joint one with the Institute of Radio Engineers. Although numerically small, the Branch membership has consistently included a high percentage of those eligible.

On Being an AIEE Student Branch Counselor

J. B. CLOTHIER, JR.
ASSOCIATE MEMBER AIEE

SO THEY HAVE ASKED YOU to be the AIEE Student Branch Counselor at your school? I wonder why they picked you. I hope you don't think it was because nobody else would take the job. No, the boys chose you because they like you and because they think that you are a capable person. Or perhaps you are being directly appointed rather than selected by the students. In either case, what are you in for? Is this going to mean the assumption of considerable responsibility, quite a bit of work, signing membership applications and seeing that they are forwarded to headquarters: telephoning prospective speakers who will come to address your branch; seeing to it that your branch will be effectively represented at prize paper competitions and at other District meetings, that your student officers are on the job, helping and advising them when they need you; checking to see that your chairman and vice-chairman are really learning how to manage the branch efficiently, that your secretary is keeping accurate records of meetings and sending in his reports to headquarters promptly, that your treasurer is keeping his accounts in such good order that the financial status (if any) of the branch is available at a moment's notice? Yes, it is probably going to mean all this and more.

So why are you willing to accept this position as branch counselor? You are taking it on for two basic reasons: first, because this work is a channel through which you can help your students; and second, it is an excellent means by which you can help yourself.

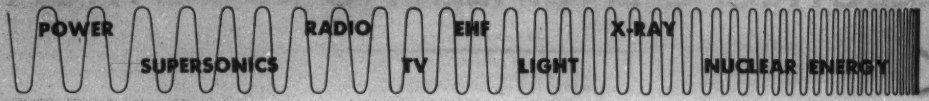
First, your AIEE Student Branch activities are intended to develop as many latent potentialities in each member as possible. The idea is to develop the whole man. Through branch activities, opportunities are afforded for the development of personality by experience in human relations. The preparation and presentation of student papers challenges the young man to develop his originality and his ability to become a competent technical writer and speaker—a very important accomplishment in the modern engineering world. Outside speakers bring to the branch members first-hand information concerning up-to-date engineering activities, along with a certain personal experience in the field of engineering that helps the undergraduates to see what the job opportunities are and to realize that mature engineers also are human beings like themselves. Nor should we fail to emphasize the importance of our magazine *Electrical Engineering* as a means by which the students become intimately familiar with the electrical engineering business. The advertisements alone provide the reader with an education in current engineering materials, apparatus, and practices. Articles concerning outstanding events and personalities provide a challenge and are a source of inspiration to the undergraduate. Technical articles of the highest quality constitute models for his own writing and speaking efforts.

Do you think that inspection trips to industrial plants of various kinds are a valuable part of your students' educational experience? If so, you will have the privilege of helping to arrange these tours and will enjoy going on them yourself, if you want to.

And how will your activities as branch counselor help you to advance in your engineering career? A mere brief consideration of the duties and responsibilities of your position brings to light the answer to this question. Do you wish to become known by other members of your profession? Do you wish to make new friends and acquaintances? You will. Every outside contact you make for your branch will result in one or more new acquaintance or in the renewal of old friendships. Every AIEE National, District, or Section meeting you attend will revitalize your association with old friends and will bring you into contact with members of your profession whom you might not meet in any other way. This is an excellent way to gain recognition in your chosen field.

Then, too, there is the privilege of visiting other schools, examining their laboratories, and learning how they do

Prof. Clothier is Student Branch counselor and associate professor of electrical engineering at Villanova University



things. This can be a fine source of ideas that may stimulate your own thinking and result in new developments in your own courses and laboratories.

The skill that you will develop in managing a group of individuals that constitute your student branch is something in the nature of executive training—something that will prove to be of increasing value to you as you advance in the engineering profession.

Then, too, you will experience satisfaction in knowing that you are doing something worth while for the engineering profession in general and you will come to see that your work is appreciated by every AIEE member from the president on down. This results in a feeling of "belonging."

In short, when all is said and done, how can you lose? As a student branch counselor, you are really in a unique position, with everything to gain.

Best of luck and more power to you and your student branch. "Close the switch and let 'er go."

RCA Establishes 30 Science Teacher Scholarships

RESPONDING to the need expressed by educators for more qualified teachers of science and mathematics, the Radio Corporation of America (RCA) has established 30 college and university scholarships for students who are preparing for the science teaching profession, Brigadier General David Sarnoff, chairman of the Board, has announced. He said:

"The RCA plan, unique among corporate educational aid programs, actually is an extension of the long-established RCA Scholarship and Fellowship Program. It provides for 30 RCA Science Teacher Scholarships which will be awarded at 20 different teacher-training colleges throughout the country."

Explaining the purpose of the scholarships, General Sarnoff stated:

"RCA recognizes the necessity for helping to increase the supply of science teachers. The progress of our industry is directly related to the supply of competent and creative scientific and engineering personnel. In turn, this supply is dependent on the quality and number of teachers at the secondary school level who will instruct our boys and girls in the scientific courses, especially physics, chemistry, and mathematics. Some of these students eventually will be tomorrow's scientists, making valuable advances in the field of electronics for home, industry, and national defense. As the result of this program and its contribution in adding to the supply of science teachers, we believe progress can be made toward achieving the long-range objective of increasing the number of engineers and scientists.

The respective college or university receiving the RCA Science Teacher Scholarships will assume the responsibility for selecting students for the scholarships each year. Selection will be based on the student's academic record, character, financial need, and desire to teach mathematics or science.

RCA Scholarships, providing an annual grant of $800, will be allotted to 10 colleges and awarded to prospective teachers being trained in the field of science and mathematics. These scholarships will be available to the student during the sophomore, junior, and senior year at the following colleges and universities: Berea College, Berea, Ky.; Adelphi College, Garden City, N. Y.; Clark College, Atlanta, Ga.; University of Delaware, Newark, Del.; Goucher College, Baltimore, Md.; West Virginia Wesleyan College, Buckhannon, W. Va.; University of Wyoming, Laramie, Wyo.; Trinity College, Hartford, Conn.; St. Louis University, St. Louis, Mo.; University of Rhode Island, Kingston, R. I.

RCA will also make an unrestricted contribution of $500 to the seven independent colleges in the group listed.

Twenty scholarships, 10 of which provide an annual grant of $800 each, will be granted to selected teacher training colleges, and awarded to junior or senior students being trained as teachers in the field of science or mathematics. In addition 10 scholarships of $250 each will be granted at these same teacher training colleges to encourage freshman and sophomore students to prepare for a teaching career. The 20 scholarships will be granted to the following colleges and universities: New Jersey State Teachers College, Trenton, N. J.; New Jersey State Teachers College, Montclair, N. J.; Eastern Kentucky State College, Richmond, Ky.; New York State College for Teachers, Albany, N. Y.; Georgia State College for Women, Milledgeville, Ga.; Henderson State Teachers College, Arkadelphia, Ark.; Western State Teachers College, Macomb, Ill.; New Mexico Highlands University, Las Vegas, N. M.; Arizona State College, Flagstaff, Ariz.; Western Washington College of Education, Bellingham, Wash.

The RCA Education Committee, under the chairmanship of Dr. C. B. Jolliffe, RCA vice-president and technical director, conducted an extensive study to determine the states which have the greatest shortage of science teachers. The committee found a very close relationship between the number of mathematics and science teachers now being graduated in various states and the estimated 1961 high school age population. This finding enabled the committee to determine the number of science teachers each state would have to produce to keep pace with its size and probable future growth. After identifying states where the most acute teacher shortages exist, colleges within each state were selected for the scholarships. Most of the colleges, selected by the RCA Education Committee, are of moderate size and draw the majority of their students from a limited geographical area.

In studying the various aspects of the science teaching problem, the committee recognized the progress already made in increasing the quality and effectiveness of science education in many states. The measure of science teacher shortage was developed by the committee solely for the purpose of making decisions regarding the scholarship awards. Based on the results of the survey, RCA's new scholarships will be distributed among 16 states which vary in size and are widely scattered throughout the nation.

64 Students Accepted for AEC Reactor School

The U. S. Atomic Energy Commission (AEC) has accepted the enrollment of 64 scientists and engineers, 51 of them from 25 foreign countries, for advanced study in the Fifth Session of the Commission's International School of Nuclear Science and Engineering at the Argonne National Laboratory, Lemont, Ill. The training program, an outstanding part of the President's "Atoms-for-Peace" program, is shared by the International School and co-operating universities, North Carolina State College and Pennsylvania State University.

This enrollment brings to 286 the number of scientists and engineers pursuing the course in unclassified reactor technology. Of these, 214 have come from 41 foreign countries. The 72 American students have been sponsored largely by United States firms interested in nuclear energy.

Students from Cuba, Ecuador, and Southern Rhodesia are first-time representatives for these countries. Other nations represented in the fifth session class include Austria, Belgium, Burma, Chile, Nationalist China, Denmark, Finland, France, West Germany, Greece, India, Iran, Iraq, Italy, Japan, Korea, Pakistan, Portugal, Spain, Sweden, Switzerland, and Turkey.

The combined training program, including two universities which have research reactors on their campuses, is an expansion of the earlier AEC reactor school program

and doubles the number of students who can receive this training.

The course is based upon lectures and seminars and the intensive training provides a general grounding in nuclear science for those participating. Practical work then follows, with such unique facilities as nuclear reactors, "hot" caves, etc., for those following their specialty.

The fifth session students began their week of general orientation in Washington, D. C., on January 28, 1957, under the auspices of the International Co-operation Administration, which provides financial support for many of the foreign students.

The students were then divided into two groups which reported on February 6 at Raleigh, N. C., and University Park, Pa., for the broad training program presented in the first 17 weeks of their study.

While this group is beginning the broad training, the fourth session students who have completed their work at these two universities will move to Argonne National Laboratory for advanced study and will complete their work in June 1957.

Pratt Institute Approves New Engineering Curriculum

The trustees of Pratt Institute, Brooklyn, N.Y., have approved a new curriculum in the school of engineering to go into effect September 1957. The man in back of the curriculum is W. E. Wilson, recently appointed dean of the engineering school, whose work for the previous two years as George Westinghouse Professor of Engineering Education at Pennsylvania State University, University Park, Pa., was to investigate problems of engineering education.

In moulding Pratt Institute's new curriculum, Dr. Wilson is applying the experience acquired as supervisor of the program at Penn State. His program conforms very closely to the recommendations of the Committee on Evaluation of Engineering Education. It has been agreed that the curricula in all branches of engineering should be the same for the first two years, except chemical engineering, which will deviate slightly. Also, it has been agreed that a curriculum in engineering science will be established. The concept of nearly three years common for all but chemical engineering has received strong support and is under study. The staff is being expanded and strengthened. A plan for adding five new men per year for five years is under way. Most of these will hold doctors' degrees or be in a position to secure them within a year or two. Graduate work is being offered and, with the faculty expanded and strengthened, it is expected that the master's degree program will be a significant one within three years, and the doctorate program within 10 years. "In order to assume a proper share of the burden of increased enrollment," says Dr. Wilson, "it will be necessary to enlarge the school. A student body of 600 in 1961 and 900 to 1,000 in 1966 is envisioned."

Harvard Plans Institute for High School Science Teachers

Leading scientists of Harvard University will join next year in a new program to stimulate high school science and mathematics.

Some 45 high school teachers will spend the academic year 1957-58 at Harvard in an Institute for Teachers of Science and Mathematics. Cost-of-living grants, including tuition, will be made to the 45 teachers selected as Fellows of the Institute.

Programs of study will be based on Harvard scientific courses modified to meet the special needs of secondary school teachers and supplemented by new offerings directly designed to give the Fellows a broad and stimulating scientific background.

Prof. E. C. Kemble, theoretical physicist with long experience in teaching elementary and advanced scientific courses, will be director of the Institute. Dr. Kemble has been closely identified with Harvard's general education program in physical science since its inception.

C. A. Compton, now science instructor at Phillips Exeter Academy, will be assistant director of the Institute.

The Institute will be under the guidance of a faculty committee of scientists, including: Prof. F. M. Carpenter, biology; Prof. J. J. Lingane, chemistry; Prof. Lynn Loomis, mathematics; Prof. J. C. Street, physics; Prof. Fletcher Watson, education; and Associate Dean Judson Shaplin of the Graduate School of Education. The Institute is under the joint sponsorship of the Faculty of Arts and Sciences and the Graduate School of Education.

The Harvard Academic Year Institute will be one of 16 similar experimental programs planned for 1957-58 at different universities scattered over the country in an attempt to alleviate the shortage of qualified high school teachers of science and mathematics. The institutes will supplement the work of the shorter summer institutes for high school science teachers recently established. Both the academic year institutes and the summer institutes are sponsored by the National Science Foundation.

An Electrical Engineer in Industry

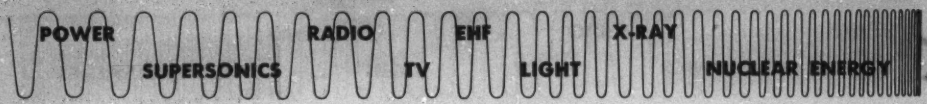
R. L. EMERY (AM '54), engineer, Pennsylvania Power & Light Company

"The AIEE has offered me a wonderful opportunity to associate with outstanding engineers in the electrical engineering profession. By attending Section and technical discussion group meetings, I have the advantage of listening to key men in industry present problems confronting electrical engineers in every field and discussing new developments with fellow engineers, all of which leads to a well-rounded education. As a Student Member and now as an Associate Member, I feel I have benefited from the information and fellowship available, as can any young electrical engineer who participates in the activities of the AIEE."

Mr. Emery graduated from the Pennsylvania State University in 1953 with a B.S. degree in E.E. Following graduation, he joined the Pennsylvania Power & Light Company, starting on the student training program. After 18 months of such training, which included every phase of the company's operations, he joined the Transmission Engineering Division of the electrical engineering department in 1955 as a junior engineer. Since then he has been designing transmission lines. Mr. Emery's engineering experience includes designing and developing transmission structures, providing overhead lightning protection, power conductor sag calculations, job estimates, and field experience,as well as many other phases of engineering covering both physical and economical requirements of transmission line design. He has recently been promoted to the position of engineer.

Mr. Emery's experience with the AIEE began when he became a Student Member in 1953. He served on the Attendence Committee of the Lehigh Valley Section, 1955-56, and was elected assistant secretary-treasurer of the Section, 1956-57.

Electrical Engineering Education



Theta Tau Holds National Convention

Theta Tau, national engineering fraternity, held its 21st Bienniel Convention at Columbus, Ohio, December 28-30, 1956. Representing 24 chapters at engineering colleges throughout the country, almost 100 delegates, national officers, alumni, and active members assembled for three days of sessions at the Fort Hayes Hotel.

National officers elected for two-year terms on the Executive Council include: Grand Regent A. D. Hinckley (M '38), executive secretary, Illuminating Engineering Society, New York, N. Y.; Grand Vice-Regent C. W. Britzius, partner, Twin City Testing and Engineering Laboratory, St. Paul, Minn.; Grand Scribe R. E. Pope, doctoral candidate, department of chemical engineering, University of Kansas, Lawrence; Grand Treasurer P. L. Mercer, plant manager, Union Electric Power Co., Keokuk, Iowa; Grand Marshal J. M. Daniels, chairman of admissions, Carnegie Institute of Technology, Pittsburgh, Pa.; Richard Lynch, O. W. Burke Co. General Contractors, Detroit, Mich.; and Prof. W. K. Rey, department of aeronautical engineering, University of Alabama.

E. J. Schrader, consulting mining engineer, Reno, Nev., continues as counsellor of Theta Tau, the lifetime office to which he was elected in 1954 at the Golden Anniversary of the fraternity of which he is the principal founder. Prof. Jamison Vawter, department of civil engineering, University of Illinois, Urbana, continues as delegate at large, being the immediate past grand regent (1952-1954). In addition to Prof. Vawter, other past officers and active participants in the fraternity's program included H. H. Hopkins, past grand regent, building material wholesaler, Evanston, Ill.; J. W. Howe, editor of the *Gear of Theta Tau*, head department of mechanics and hydraulics, State University, Iowa City, Iowa; and E. E. Knorr, president of the Central Alumni Association of Theta Tau.

Following tradition, and in recognition of his many years of service to the fraternity in many offices, including Grand Regent, the current convention was named for Prof. D. D. Curtis, head of the mechanics department, Clemson Agricultural College, S. C.

The host chapter for the convention is located at Ohio State University. Arrangements for the convention were made by the campus committee headed by C. M. Hagedorn. The general committee for the convention includes: Chairman R. G. Glass, vice-president, Moore and Glass, Cleveland, Ohio; also Prof. E. D. Ayres (M '31), department of electrical engineering, Ohio State University; W. A. Flack, senior, College of Engineering, Ohio State University; Ramond Hanes, State Highway Department, Columbus, Ohio; P. L. Mercer, grand treasurer; and R. E. Pope, grand scribe.

Significant actions taken during the convention included the strengthening of the fraternity's expansion program by the authorization of a new post of traveling secretary. Also approved for the coming Biennium is the appointment of four regional officers who will assist the Executive Council in stimulating and co-ordinating the national program. As a guide to all chapters, a new recommended Pledging Code was adopted. Approval was given to the continuation of the regional meetings which have proved so valuable during the interim between conventions.

Numbering over 14,000 members, Theta Tau Fraternity was first established at the University of Minnesota in 1904. As the principal professional engineering fraternity in this country it numbers among its members outstanding leaders on each campus and in all the engineering fields.

Doctoral Program in Electrical Engineering Offered

The electrical engineering department of the University of Connecticut has established a doctoral program in the field of "Network Theory and Feedback Control Systems." A program in this field leading to the M.S. degree has been operating there since 1950 and the curriculum and research activities have expanded to the point where it is appropriate to offer doctoral level work as well. The present electrical engineering graduate curriculum involves 28 regular courses on the graduate level and, in addition, various specialized courses pertaining to specific problems which are offered as interest warrants. The advisory committee for this program consists of Professors V. B. Haas, R. J. Kochenburger, and H. M. Lucal. In addition, other members of the faculty will participate in the course work involved.

Intensive Courses in Automatic Control Scheduled

The University of Michigan, college of engineering, has announced two summer intensive courses in automatic control. The first is scheduled for June 17-22 inclusive, and the second for June 24-26, 1957, inclusive. The courses are intended for engineers who find it necessary or who wish to obtain a basic understanding of the field, but who cannot spare more than a few days for this purpose. The aim of the courses is to make it easier to learn by a coherent presentation of the fundamentals of modern automatic control and by providing a comprehensive set of notes to serve as a framework for further study.

The courses are built around the principles and application of measurement, communication, and control. Course I will consist of the fundamentals in each of these fields and will include some basic work in nonlinear systems. Course II will take up applications of the fundamentals to more advanced problems. There will be four hours of lecture each morning and three hours of laboratory demonstration in the afternoon. Extensive use will be made of computing, instrumentation, and servo laboratories on the campus. The role of analog computing methods will be emphasized. These courses have been given previously in the summers of 1953, 1954, and 1955.

April 15, 1957, is the closing date for registration. Further information may be obtained by writing to Prof. L. L. Rauch, Room 1521, East Engineering Building, University of Michigan, Ann Arbor, Mich.

New Members of Eta Kappa Nu Announced

Two evening session students are among seven midyear initiates of the campus chapter of Eta Kappa Nu, the national honorary electrical engineering society, at the Polytechnic Institute of Brooklyn.

According to Arthur Sapelli, 1956-57 president of the chapter, membership in Eta Kappa Nu is recognized everywhere by the electrical industry as the highest honor to be achieved in his field by an undergraduate or graduate student.

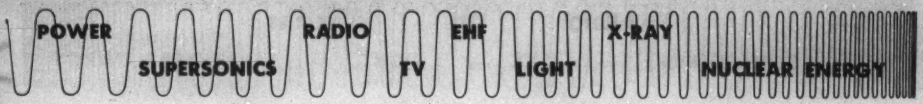
The two initiates from industry who are seniors in the undergraduate evening session are J. J. Priest, East Meadow, N. Y., and Irving Goodman, Brooklyn, N. Y. Undergraduate day seniors are: J. F. Davis, Brooklyn, N. Y.; J. M. Brown, Malverne, N. Y.; and Nils Ljungman, Brooklyn, N. Y.

Junior students in the undergraduate day session whose records won them membership in the society are: N. K. Keller, Long Island City, N. Y. and M. H. Pollack, Brooklyn, N. Y.

Business Training College Seeks Additional Technical Data

The Business Training College, Wood St. and Boulevard of the Allies, Pittsburgh, Pa., is requesting the engineering profession to furnish it with terminology and technical information which can be used in dictation and transcription training of young men and young women as engineering secretaries.

Dean P. E. Davis initiated the course and styled it after the medical secretarial program which the college has offered for more than 12 years. At the present time, increasing numbers of high school students in many parts of the country are evidencing interest in the program which will train them to become aids and assistants to busy



engineers. However, the dean is extremely anxious that the students receive background and training in the terminology which is used in the various professional groups, particularly in the chemical, electrical, aeronautical, and industrial engineering fields. Other fields of interest include mechanical and metallurgical terminology and technical data.

Carbon copy dictation, booklets of instruction, employee manuals, dictionaries or lists of specific terminologies, technical specifications, research reports, and industrial books which have been prepared by the profession would be of extreme value in expanding the dictation and transcription curriculum at the college.

Correspondence may be sent directly to Dean Phyllis E. Davis, Business Training College, Wood St. & Boulevard of the Allies, Pittsburgh 22, Pa.

Wayne State University Offers Special Summer Program

The Computation Laboratory of Wayne State University, Detroit, Mich., is offering its fifth special summer program of three weekly courses. Experts from various parts of the country and the staff of the laboratory will participate and bring to the course their experiences and new ideas. The Computation Laboratory equipment, plus other machines brought to the university for this purpose, will be available to the students for laboratory work.

The titles and dates of the three courses are: Introduction to Computers and Their Applications, June 3-8; Data Processing in Business and Industry, June 10-15; and Industrial and Management Computer Applications, September 9-14.

For further information write to A. W. Jacobson, director, Computation Laboratory, Wayne State University, Detroit 2, Mich.

Knoxville Section Holds Meeting with Student Branch

The January meeting of the AIEE Knoxville Section was held jointly with the University of Tennessee Student Branches of AIEE and the Institute of Radio Engineers.

Speaker for the meeting was Dr. W. F. Gauster of North Carolina State College and the Oak Ridge National Laboratory, who made an interesting comparison of engineering education and training practices in Europe and in the United States.

Dr. Gauster was introduced by Prof. C. H. Weaver, professor of electrical engineering, University of Tennessee, and counsellor for the AIEE Student Branch. The attendance at the meeting was 103.

Graduate Summer Session in Statistics Has Been Scheduled

The fourth Southern Regional Graduate Summer Session in Statistics will be held during the summer of 1957 from June 12 through July 20 at the Virginia Polytechnic Institute, Blacksburg, Va. The three previous sessions were held at the Virginia Polytechnic Institute, the University of Florida, and North Carolina State College in that order. In 1958, the summer session will be held at Oklahoma Agricultural and Mechanical College. Students who attended past sessions came from all of the 48 states, South America, India, Finland, Canada, Australia, Hawaii, China, the Philippines, and Africa. The enrollment at each of these sessions has exceeded 100 graduate students.

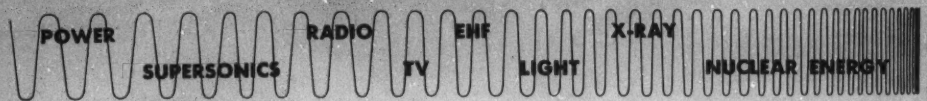
The summer sessions are designed to carry out a recommendation of the Southern Regional Education Board's Committee on Statistics, on which the four institutions initiating the program are represented. The sessions will be of particular interest to (1) research and professional workers who want intensive instruction in basic statistical concepts and who wish to learn modern statistical methodology, (2) teachers of elementary statistical courses who want some formal training in modern statistics, (3) prospective candidates for graduate degrees in statistics, (4) graduate students in other fields who desire supporting work in statistics, and (5) professional statisticians who wish to keep informed of advanced specialized theory and methods.

Each annual summer session lasts six weeks and each course offered carries approximately five quarter-hours of graduate credit. The program may be entered at any session, and consecutive courses will be offered in successive summers. The summer work in statistics may be applied towards residence requirements at any one of the co-operating institutions, as well as certain other institutions, in partial fulfillment of residence requirements for graduate degrees.

The faculty for the 1957 session at the Virginia Polytechnic Institute will include E. J. Williams, principal research officer, Commonwealth Scientific and Research Organization, Division of Mathematical Statistics, Melbourne, Australia; D. B. DeLury, director of statistics, Ontario Research Foundation, Toronto, Ont., Canada; J. L. McHugh, director, Virginia Fisheries Laboratories; and the following staff members from the Virginia Polytechnic Institute: W. O. Ash, L. S. Brenna, R. A. Bradley, C. W. Clunies-Ross, J. E. Freund, R. J. Freund, Boyd Harshbarger, C. Y. Kramer, and R. L. Wine.

Of particular interest at this summer session will be the lectures by D. B. DeLury on the "Sampling of Biological Populations." This course will cover the study of statistics of biological populations with specific reference to marine research. It will include some of the more recent research in this field by Dr. DeLury, and it will be accompanied by a laboratory conducted by J. L. McHugh dealing with problems, exercises, and discussions. E. J. Williams will give a course on the "Analysis of Variance" from the regression point of view with generalizations to multivariate analysis. Much of his lectures will deal with new material

DR. W. F. GAUSTER addressing a joint meeting of the AIEE Knoxville Section and the University of Tennessee Student Branches of AIEE and IRE.



that he is now putting in book form. R. A. Bradley will be giving a course on "Rank Order Statistics" and will include some of the more recent research that he has published or is in the process of publishing in this field. J. E. Freund will give a course in "Stochastic Processes," with particular reference to engineering applications. He will present many of the more recent advances in this field as well as his own research. The other graduate courses will include "probability" by C. W. Clunies-Ross, "Statistical Inference" by W. O. Ash, "Theory of Least Squares" by R. L. Wine, "Statistical Methods" by C. Y. Kramer, "Engineering Statistics" by L. S. Brenna, and "Sampling" by R. J. Freund. Seminars which will include many of the foremost statisticians in the eastern part of the United States, will be conducted Monday through Thursday from 3:00 to 4:30 p.m. These seminars will be on some of the more recent research now being carried on in the field of statistics.

The total tuition fee will be $38 for the six-week term. Doctoral courtesy will be offered to those holding doctoral degrees. Living and other expenses at the Virginia Polytechnic Institute are reasonable. Inquiries should be addressed to Boyd Harshbarger, head, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Va.

Stromberg-Carlson Announces Liberalized Tuition-Aid Program

A liberalized tuition-aid education program for employees of Stromberg-Carlson, a division of General Dynamics Corporation, has been announced by President R. C. Tait.

Under the revised program, the company will pay all tuition costs for regular full-time employees who are taking evening or extension courses directed toward advanced degrees, and half the tuition costs for those studying on the undergraduate level, up to a maximum of $250 per calendar year.

Mr. Tait explained that previously the company had paid only half the tuition costs of any course of study undertaken by an employee, and the maximum had been $75 a year.

The liberalized program was instituted, Mr. Tait explained, because Stromberg-Carlson is anxious to share the cost of individual improvement. Now, more than ever before, there is a need for men with advanced training, not only in the technical fields but in other fields as well, he said.

More than 425 employees, or about 6% of the company's 7,100 employees, are enrolled in study courses at the Rochester Institute of Technology, the University of Rochester, Rochester Business Institute, other vicinity institutions, and some in correspondence schools.

All courses which are part of a planned degree program qualify for tuition aid, as do courses which are determined by an applicant's supervisor to be helpful in his job, Mr. Tait said.

He pointed out that interest in additional education has grown considerably in the past few years. Because the value of education is a double one, beneficial to both the individual and the company, Mr. Tait said, the company conducts an extensive in-plant program in which regular instructors conduct specific courses at no cost to the employees.

Among these are courses on components identification, blueprint reading, graphic presentation of data, and inspection procedures.

Employees also attend classes in a six-week course in Stromberg-Carlson's "XY" School, which is conducted for those who are concerned with the installation or maintenance of the company's "XY" telephone switching systems.

Plans Made for Expanded Traveling Teacher Program

The National Science Foundation (NSF) has announced a grant of $115,800 to the Oak Ridge Institute of Nuclear Studies (ORINS), Oak Ridge, Tenn., to carry out an expanded Traveling Science Demonstration Lecture Program for 1957-58.

Plans are proceeding for the 1957-58 program while seven "traveling science teachers" are touring scores of United States high schools under the 1956-57 program, giving special demonstrations to science classes and conferring with teachers and administrators.

Sponsored by the NSF in co-operation with the U. S. Atomic Energy Commission (AEC), which is contributing $38,000, this unique "traveling teacher" program is designed to stimulate interest in science and science-teaching careers on the part of secondary school students.

Notification of the grant was made to Dr. W. G. Pollard, executive director of ORINS, and to Dr. W. W. Grigorieff, chairman of ORINS' University Relations Division and program director of the Traveling Science Demonstration Lecture Program.

Announcements about the program for the 1957-58 school year are being sent to 30,000 high schools throughout the United States. These announcements contain blanks to enable individual high schools to request visits by a teacher; also included is information for teachers who wish to apply for appointments as "traveling teachers" for 1957-58.

The seven teachers currently on tour will visit approximately 200 schools before the end of this school year. It is expected that the traveling staff for the 1957-58 program will be considerably expanded, so that a greater number of high schools can participate in the coming year.

The present group of "traveling teachers" was chosen from more than 100 applicants from secondary schools all over the country. In the first stage of their training, they attended a one-month summer institute in science teaching, held at ORINS under NSF sponsorship. The remaining two summer months were spent in additional training at Oak Ridge; this time was devoted to evaluation of teaching techniques and the development of simple, inexpensive science equipment to be used in high-school demonstrations.

In September 1956, when the teachers started on their tours, they were provided with new station wagons supplied by the Ford Motor Company, which were outfitted with more than 800 pounds of apparatus developed during the summer. Gas and oil supplies for the station wagons are being provided by the Gulf Oil Corporation.

The program is administered for the NSF and the AEC by the University Relations Division of ORINS, a nonprofit educational corporation of 35 southern universities. Further information concerning the program and brochures announcing the 1957-58 activity can be obtained by writing Oak Ridge Traveling Science Demonstration Lecture Program, University Relations Division, ORINS, P.O. Box 117, Oak Ridge, Tenn.

Two Former Deans Honored by Penn State

Two former deans of the college of engineering and architecture at the Pennsylvania State University, University Park, Pa., have been honored with the naming of two campus buildings.

Main engineering building, constructed in 1929, has been designated Sackett Building, honoring the late Dr. R. L. Sackett, while an engineering building to be constructed by the General State Authority, will be known as Hammond Building, honoring the late Dr. H. P. Hammond.

Dr. Sackett, who died October 6, 1946, went to Penn State in 1915 from Purdue University and served as dean of the college of engineering and architecture until his retirement with emeritus rank in 1937. He was born in Mt. Clemens, Mich., and received his B.S. degree in civil engineering, and the degrees of civil engineer and D.Eng., all from the University of Michigan.

Dr. Hammond succeeded Dr. Sackett as dean in 1937 and served until his retirement with emeritus rank in 1951. He died two years later.

Born in Asbury Park, N. J., Dean Hammond was a graduate of the University of

Pennsylvania and received the degree of D.Eng. from Case School of Applied Science and the LL.D. degree from the University of Vermont. He served on the faculty of the University of Pennsylvania and Lehigh University before going to Polytechnic Institute of Brooklyn in 1913 where he remained until 1937.

Both Dean Sackett and Dean Hammond were recipients of the Lamme Award, the highest honor in the field of engineering education.

Foreign Study Opportunities Are Available to U. S. Citizens

In the *Newsletter* of the U. S. National Commission for United Nations Educational, Scientific and Cultural Organization (UNESCO), it was announced that hundreds of foreign study opportunities in fields ranging from economics to electron optics are now available to United States citizens who can qualify on the basis of education or experience. The grants, which include tuition and living expenses in most cases, are offered by countries in Europe, Asia, the Middle East, and Latin America as their contribution to the "exchange of persons" program.

The Institute of International Education (IIE) announced that an applicant who meets the prescribed qualifications might receive a "poste de lecteur" at a French university or, perhaps, study theology under one of the 68 scholarships offered by West Germany. Some of the universities named by IIE include Oxford, the Sorbonne, Padua, the Free University of Berlin, the University of Lausanne, and others.

Qualifications vary with the particular award; Italy, Israel, Denmark, Sweden, and The Netherlands offer university scholarships for which there is no language requirement and in some instances, preference will be given to those who have not already studied abroad. Further information may be had by contacting the Institute of International Education at 1 East 67th St., New York, N. Y., or 116 South Michigan Ave., Chicago, Ill.

Nuclear Reactor Center Aids University Research Programs

The establishment of a Nuclear Reactor Center in West Caldwell, N. J., has been announced by Dr. Stephen Malaker, general manager of Daystrom Nuclear, a division of Daystrom, Inc.

The announcement was made following approval by the mayor and town planning board of West Caldwell for Daystrom Nuclear to establish a nuclear reactor center within the corporate limits of the town.

Dr. Malaker stated that his research and administrative staff will move at once into a 36,000 square foot laboratory, where an "Argonaut" reactor is to be installed. Here college and university faculty members from throughout the country can be trained in the peacetime use of nuclear reactors. In this nation's newest nuclear center, Daystrom Nuclear will also go into quantity production on a 10-kw Argonaut research reactor that will be available for the first time to colleges and universities, as well as to industry.

The purpose of this new Daystrom Reactor Training is to implement the vast peacetime atomic training program which is to be sponsored by the Atomic Energy Commission (AEC).

"For the United States to maintain leadership in all phases of atomic development it is vital that our colleges and universities embark on a wider program of training nuclear students in reactor use," Dr. Malaker stated.

"It is our purpose in West Caldwell to indoctrinate selected university personnel so they may return to their respective schools as reactor operators licensed by the AEC, and capable of instructing students in reactor use," Dr. Malaker added.

The success of this move to build up a vast reservoir of nuclear engineers skilled in the use of reactors is dependent upon the ready availability of low-cost reactors for campus research. As part of its long-range plan, described as the "Dart" plan by Dr. Malaker, Daystrom Nuclear will manufacture research reactors at a low cost capable of producing 10 kw of power.

Under the Dart plan, Daystrom Nuclear will offer colleges and universities a nuclear "package" that will include training of personnel at the West Caldwell laboratories, formal engineering surveys of campus reactor sites, complete installation of an Argonaut 10-kw reactor, and continuing consultation of reactor applications and uses.

Series of Books on Electronics Issued

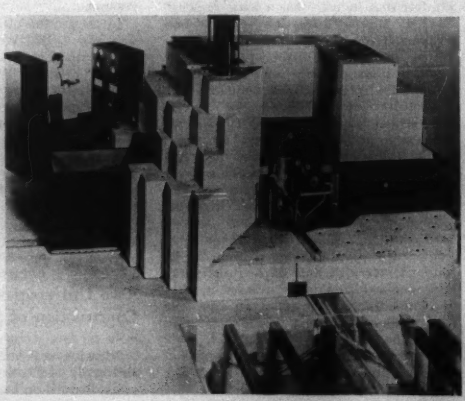
Dr. H. A. Romanowitz, professor and head of the department of electrical engineering at the University of Kentucky, is the author of a trilogy of books on electronics which were released for distribution January 8, 1957.

The series, which includes a textbook, a laboratory manual, and an instructor's handbook, has been designed as a complete course in electronics principles, according to Dr. Romanowitz, who has been on the university faculty for 15 years.

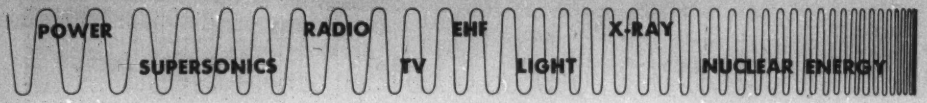
A basic course in electronics, at the college level, can be established with the aid of these publications in institutions previously unable to offer such a course, the professor pointed out.

The books provide not only background material in physics to support the presentation of electrical theory, but also assistance to the instructor who has had no formal training in electronics. The 80-page instructor's handbook contains solutions to the textbook problems, sample data on all experiments, and specifications on the performance of experiments and the apparatus required.

In the laboratory manual are instructions to the student for performance of 22 basic experiments in electrical engineering and electronics.



SCALE MODEL of the Dart reactor which will be installed by Daystrom Nuclear at West Caldwell, N.J., for the training of university faculty members. The cut-away section of the reactor shows controls, operating instrumentation, control rod drive mechanisms, fuel rods, reactor inner tank, and the building block type construction which houses the reactor unit.



The 300-page textbook includes, in addition to a presentation of electronics fundamentals, material on electric circuits, fields, and instruments. The recently developed transistor and magnetic amplifier are given introductory treatment.

Colleges with physical science departments, technical institutes, nonelectrical departments in engineering colleges, junior colleges, and evening schools are in need of a text and associated manuals of this kind, in the training of scientists and engineers, Dr. Romanowitz said.

Publisher of the trilogy is the Bradford Press, 125 Eastin Rd., Lexington, Ky.

IBM Launches Scholarship Program

One of the largest industrial scholarship programs ever launched—calling for an average annual expenditure of approximately $250,000 when in full operation—has been announced by International Business Machines Corporation (IBM). The program has been developed in honor of the late T. J. Watson, IBM Board chairman, and will be known as IBM's Thomas J. Watson Memorial Scholarship Program.

J. M. Stalnacker, president of National Merit Scholarship Corporation, which will co-operate in administering the program, referred to the new IBM plan as a "foremost example of the growing and generous contribution of industry to meet American educational needs."

In announcing the new program, T. J. Watson, Jr., IBM president, said, "No part of the American economy is more dependent on well-trained young people than industry. We feel that industry has a basic responsibility to support education and our new program is one of our continuing efforts to assume this responsibility."

IBM's plan provides for 50 four-year scholarships to be awarded annually on a competitive basis. Twenty-five will go to high school seniors who are children of IBM employees, and 25 to other high school seniors in public, private, and parochial schools throughout the nation. This means that four years from now 200 students will be receiving benefits each year from the program.

In addition, a minimum of 25 matching scholarships will be awarded annually by National Merit Scholarship Corporation. Each scholarship, whether awarded by IBM or National Merit, includes an equitable cost of education grant to the institution selected by the scholarship recipient.

Recipients will be selected on the basis of merit, without regard to financial need. The amount of the award, however, will vary from a minimum of $100 per year to the full cost of education, and will be determined by the National Merit Scholarship Corporation on the basis of need.

T. J. Watson, in whose memory the scholarships will be awarded, was head of IBM from 1914 until his death in 1956. Throughout his entire career he was deeply interested in education and supported it in many ways.

New Position Created at Brooklyn Polytechnic Institute

Creation of a new administrative position, vice-president for research, and the appointment of Dr. Ernest Weber (F '34) as the first person to hold that position, has been announced by Dr. H. S. Rogers, president of the Polytechnic Institute of Brooklyn.

Creation of the vice-presidency was called for by the marked growth of research projects at Polytechnic which now represent annual expenditures of more than $2.25 million according to Dr. Rogers.

Prior to assuming this post, Dr. Weber was director of Polytechnic's Microwave Research Institute (MRI), considered to be one of the nation's most important centers of electronic research. Under his direction, MRI annually expended almost $1 million on research projects for the armed forces.

A native of Vienna, Austria, Dr. Weber went to Polytechnic in 1930 as a visiting professor. Early in World War II, he organized a group of experts in microwave research which largely was responsible for the invention and production of the precision microwave attenuator, a device which made possible the accurate calibration of radar receivers.

In recognition of his contributions to the war effort, Dr. Weber was awarded the Presidential Certificate of Merit.

Since 1945, Dr. Weber has been head of Polytechnic's department of electrical engineering and director of MRI.

He is chairman of the Development Advisory Council, U.S. Air Force Air Research and Development Center, Rome, N. Y.; past president of the New York Electrical Society, and a fellow of the Institute of Radio Engineers and the American Physical Society.

Two Universities To Begin Construction of Synchrotron

Scientists at Princeton University and the University of Pennsylvania after some two years of work on basic designs are reaching the final planning stages for the construction at the James Forrestal Research Center of a 3 billion volt, high intensity proton accelerator, or synchrotron, that will cost more than $6 million.

The new machine, which will be largely financed by the U.S. Atomic Energy Commission (AEC) and which will be used under the joint administration of Princeton and Pennsylvania for unclassified research directed solely towards an increase in the basic knowledge of matter, is expected to produce heavy mesons in much larger quantities than has heretofore been possible.

Heavy mesons, unstable elementary particles that disintegrate spontaneously in a fraction of a second and have only a transient existence in cosmic rays, have been produced artificially by the large accelerators at the Brookhaven National Laboratory at Upton, N. Y., and the Radiation Laboratory of the University of California at Berkeley.

Designed to produce at least 50 times the proton current now available from existing accelerators, the Princeton–Pennsylvania synchrotron will have a much greater beam intensity than either the Brookhaven cosmotron or the bevatron at California. Comparable in size to the cosmotron, it will have an energy equal to the 3-bev Brookhaven machine and will have one half the energy of the bevatron.

As the first step in the three-year construction program, it was announced by Dr. M. G. White, Eugene Higgins professor of physics at Princeton and director of the project, that Princeton has retained Gibbs & Hill, Inc., New York, N. Y. consulting engineers, as architect-engineers for the project. This firm will also assist in the supervision of its construction.

The new accelerator will consist of an a-c electromagnet, measuring some 80 feet in diameter and weighing 400 tons. It will be housed in a circular building that will be totally shielded by a massive earthen embankment.

The Princeton–Pennsylvania accelerator, with Princeton taking prime responsibility for its design, construction, and operation under a contract with the AEC, will be available for use by other Middle Atlantic States institutions engaged in very-high-energy physics research.

The membership of the joint administrative committee, headed by Dr. White, includes two members of the Pennsylvania Faculty, Professors Walter Selove and Donald Murray, and Professor G. T. Reynolds, of the Princeton department of physics. Other members of the committee are Dr. J. H. Wallace, Jr., administrative director of the James Forrestal Research Center; R. J. Woodrow, executive secretary of the Princeton Board of Scientific and Engineering Research; and Dr. R. A. Winters, of Princeton, who is serving as committee secretary.

OF CURRENT INTEREST

A "CAVE" — in the atomic sense — has thick concrete walls, multi-ply window glass, and robot arms which allow the atomic scientist to work with highly radioactive materials.

Ventilation Details of Atomic Laboratories Are Vital

WHEN FUTURE HISTORIANS analyze the atomic age, it is safe to predict they will credit its rapid maturity to the ingenuity of the so-called "safety engineers" as well as to the discoveries of the physicists. For without the imagination and skill of those concentrating on precautionary measures, the scientist would have little opportunity to work in radioactive areas.

Consider just a few of the safety devices born in atomic energy laboratories:

> New materials and entirely different types of construction have been developed. Highly sensitive testing instruments to detect the slightest trace of contamination have been invented and elaborate forms of protective clothing have been fashioned.

But over and above all such measures there has been the never-ending problem of keeping scientists and staffs from breathing even the most minute radioactive particles. This has called for new techniques and skills in air conditioning and ventilation.

Just how is an air conditioning system set up to avoid an accumulation of radioactive particles in the nooks and corners of the lab or, much worse, in the air?

According to engineers at Worthington Corporation, which built the air conditioning systems for the three largest U.S. atomic energy installations, a ventilating pattern must be created that provides a continual flow of air from the worker, across his work, and into an exhaust. The ventilating engineer must never allow air that has touched radioactive material to flow back over the worker. He must never allow radioactive particles to gather in dangerous quantities.

It sounds simple, but actually it is quite complicated.

For instance, each device used in atomic research work must have its own, individual air conditioning system. These devices include such odd-named items as a "hood" and a "cave."

The "hood" is a completely enclosed workbench used when experiments are being conducted with radioactive materials of such low intensity that they will not harm anyone coming into contact with them for short periods. It has sliding glass panels on its front through which the scientist may see his work and reach it.

Some hoods have built-in sleeved gloves in the front panel. The scientist can put his hands in the gloves and actually touch the material with which he is working during the experiment.

No rough edges or cracks are allowed on the inside walls of the hood and all corners are rounded off for easy cleaning.

The "cave" is much larger and far more complicated. It is a miniature concrete room with thick glass windows that allow the scientist to see his work and robot hands that allow him to manipulate it. In cases where extremely radioactive materials must be used, the "cave" may have no windows at all and the scientist watches his experiment in progress on a television screen. Color and three-dimensional television are recent innovations that aid in this work.

Within the "hood" and "cave," two devices are used to insure against radioactive buildup. High velocity fans blow the contaminated air from the chamber through "pre-filters," which glean the radioactive particles from the air. The "pre-filters" are so named because the air passes through them before it reaches the exhaust ducts and final filters. They are installed at the rear of the "hood" or "cave" and—again following the rule against rough edges or cracks—are mounted flush.

The ventilation engineer in the atomic laboratory sometimes runs into the problem of condensation in the exhaust duct. In this case, an installation is made of a liquid-tight trough on the lower portion of the duct just beyond the "pre-filters" to catch the condensation, and a drain pipe, connected to a suitable waste facility, to carry it away.

In the "cave," exhaust fans are provided for each piece of equipment to be used in the experiment, i.e., robot arms, television camera, table on which the work is con-

ducted. According to the engineers, the ventilation specialist must keep each piece of equipment as uncontaminated as if it was in the open laboratory. This is done so the scientist can enter the "cave" immediately after an experiment to see the results of his work, make adjustments or set up new experiments.

After the air is exhausted from the protective devices, it must be cleaned again in a special, highly efficient filter system.

Finally, it is blown out a stack, the height of which is determined by meteorologists to make certain the atmosphere will dilute any minute quantities of radioactive material that might still remain.

Throughout this entire operation, the filter system plays an important role. There can be up to three sets of filters: inlet filters, pre-filters, and final filters.

The inlet filters are used to remove from the air entering the laboratory any dust that would tend to interfere with experimental work.

In each of these three operations, a filter is used that is flameproof yet combustible in a hot fire so it may eventually be destroyed.

The air conditioning in the atomic energy laboratory, the air-conditioning engineers add, must also provide regulated humidity as well as cooling and filtering. Low humidity would create an atmosphere in which static electricity could gather and possibly touch off a dangerous spark. High humidity would cause the filters to clog, thus disrupting the air flow.

Finally, there must be safeguards against any sudden stoppage of the system. Worthington engineers explained that they try always to maintain an adequate safety factor so that if any of the fans should break down, the pattern of air flow would still be maintained, even though it would be less air moving at a slower speed.

It is this type of skillful planning and unceasing care that is enabling today's nuclear scientist to bring new miracles of atomic power out of a "hood" and a "cave."

Ultraviolet Closed-Circuit TV Gives Data on Live Normal and Cancer Cells

AN APPLICATION of closed-circuit television that provides immediate comparative data of chemical activity within live normal and cancer cells was reported recently by A. L. Malcarney, vice-president and general manager, Radio Corporation of America (RCA) Commercial Electronic Products.

The new technique, made possible by a developmental RCA ultraviolet-sensitive television camera tube is undergoing experimental examination at the National Institutes of Health (NIH), Bethesda, Md.

The RCA ultraviolet television system is being used with a high power microscope and an electronic oscilloscope to obtain direct observations and oscillographic measurements of the metabolism of living cells, according to Dr. G. Z. Williams, chief of the NIH clinical pathology department, and research pathologist of the National Cancer Institute of the NIH.

"The successful application of ultraviolet television to medical microscopy and oscillographic spectroscopy," said Dr. Williams, "gives promise of new speed and facility in the analysis of cells and tissue." The system introduces numerous advances in cell research:

1. For the first time, it enables researchers to observe and take motion pictures, simultaneously, of chemical activity within living cells.

2. It makes possible microscopic study and analysis of hundreds of living cells in only a fraction of the time formerly required.

3. It makes possible direct observation and rapid, accurate measurement and identification of certain chemical changes within the cells.

Mr. Malcarney said that the ultraviolet television system utilizes a standard RCA black-and-white television camera, type *TK-21*, which is widely used throughout the television broadcast industry. The camera's standard monochrome Vidicon tube has been replaced with the experimental RCA ultraviolet-sensitive Vidicon camera tube. The pickup tube and its circuitry were developed originally at RCA's David Sarnoff Research Center by A. D. Cope and L. E. Flory, under the supervision of Dr. V. K. Zworykin, and furnished to Dr. Williams for the cell-research program at NIH.

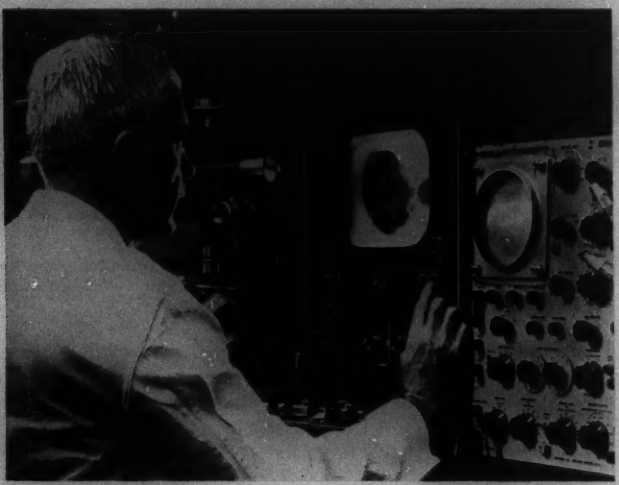
The NIH is the principal research arm of the United States Public Health Service. It embraces seven research institutes, each devoted to specific medical studies, and a clinical center which provides patient care for the various institutes.

This ultraviolet closed-circuit television system makes it possible to obtain quick and accurate measurements of ultraviolet absorption in healthy and abnormal cells and the direct oscillographic analysis and record of any part of the object-image provides immediate comparative data.

Ultraviolet rays are absorbed in specific and measurable quantities by different chemicals. This characteristic enables the medical researcher to: (1) identify the nature and scope of several cellular chemical substances by exposing the cell to ultraviolet light and measuring the absorption ratio; (2) introduce foreign chemicals and study their reaction with the cell's normal chemicals: and (3) by ultraviolet exposure, to maintain serial studies of disease-suspected cells and tissues and detect and identify chemical changes which may develop.

The over-all ultraviolet equipment chain, devised by Dr. Williams, includes an ultraviolet light source, a high-power microscope, the RCA broadcast television camera with ultraviolet camera tube, a monitor, an oscilloscope, and various motion picture cameras for filming images on both the television monitor and the oscilloscope.

In operation, the ultraviolet light source is focused on the specimen under the microscope. The RCA camera is mounted so that it "peers" through the eye-piece of the microscope. Sensitive to ultraviolet, it "sees" and transmits to the monitor an image of the cell and the action and reaction of its ultraviolet-absorbing chemicals, both those



R.C.A. Photo

COMPARATIVE DATA of chemical activity within live normal and cancer cells is provided immediately by new application of television camera with ultraviolet sensitivity. Dr. G. Z. Williams examines a televised specimen on systems monitor.

normal to the cell and those induced artificially or by disease.

"In its present stage of experimentation," Dr. Williams said, "the ultraviolet television–microscope system must be considered as a developmental technique, but one which holds important implications for future medical research. It offers significant possibilities also as an important diagnostic medium, for rapid determination of the nature of a diseased cell by direct ultraviolet television observation and measurement of the rate, scope, and shape of abnormal chemical changes."

Research Yields Solid-State Microwave-Frequency Oscillator

THE FIRST SUCCESSFUL operation of a completely new solid-state device which will oscillate at microwave frequencies has been achieved by Dr. Derrick Scovil, Dr. George Feher, and Dr. Harold Seidel at Bell Telephone Laboratories.

The idea for this new electronic device was first proposed by Prof. N. Bloembergen of Harvard University, in a recent article in *The Physical Review*. The idea was also conceived and was enlarged upon by Dr. Scovil.

The device, which might be called a spin oscillator, will also operate, in principle, as an amplifier. This development marks another significant advance arising from research in solid-state physics at Bell Laboratories, where the transistor and other related devices were invented.

One of the outstanding characteristics of the device is that it is expected to have very low noise compared with conventional microwave devices. Thus, in theory, it could extend markedly the range of radio astronomy and could result in radically new long-distance communication systems to carry television programs and telephone calls across the continent.

The experiment demonstrating the operation of the new device was performed at the Bell Laboratories at Murray Hill near Summit, N. J., November 27, 1956. At that time, Drs. Scovil, Feher, and Seidel, using a crystal containing a small amount of a paramagnetic salt, produced continuous oscillations at 9,000 mc with a power output of about 20 microwatts.

New Microwave Power Source

Thus, a completely new source of microwave power operating under new physical principles was demonstrated, and scientists believe it is only a question of time until microwave amplification can be obtained employing such crystalline materials and operating under the same physical principles as the oscillator.

Although this experimental result is completely new, the possibility of such an occurrence has been the subject of studies and speculative discussion by a number of physicists for some time. The development represents the first successful application to a solid-state device of a relatively new principle, which has been called the "maser" principle. "Maser" was first demonstrated for molecular beams in gases in 1954 by Prof. C. H. Townes and his collaborators at Columbia University. They coined the word "maser," which stands for "microwave amplification by stimulated emission of radiation." Recently there has been steadily increasing excitement among physicists, who have been trying to apply the "maser" principle to solids. Combrisson, Honig, and Townes at Ecole Normale Superieure in Paris, France, attempted one such application, which was partially successful.

This device, which is still in an early research stage, is expected to have novel and useful characteristics. Because it operates with electron spins in a paramagnetic crystal, theory predicts that it should have very low inherent noise compared to ordinary electronic oscillators or amplifiers which depend on the motion of charged particles at high temperatures. Therefore, it may be possible to amplify extremely weak radio signals—signals which may be several hundred times weaker than those usable at present.

Potentialities appear to exist for useful and novel microwave devices operating in the centimeter and millimeter wave region, although these experiments on a solid-state device are still in a very early research stage. As an amplifier, it should be moderately broadband with a bandwidth of the order of 100 mc and easily tuned, because its frequency is proportional to the applied magnetic field.

Preliminary theoretical estimates indicate that a noise figure corresponding to thermal noise at perhaps 5 or 10 degrees Kelvin should be attainable. This is hundreds of times better than is now available with conventional microwave circuitry and if realized in practice will open wide new vistas in the microwave field.

Principles of Operation

The basic operation of this particular type of solid-state device can be explained roughly by assuming three different energy levels for the unpaired spinning electrons in a paramagnetic crystal lattice in a magnetic field. Normal electron spin states are such that the number in state 1 (lowest energy state) exceeds the number in state 2, which in turn exceeds the number in state 3. By irradiating with sufficient microwave power of the proper frequency, transitions from state 1 to state 3 take place until the populations of these two states are essentially equal (power saturation).

Under these conditions the population of state 2 can be made greater than that of state 1. If a small signal is applied at a frequency corresponding to the energy difference between these two, then stimulated radiative transitions will occur, and power gain will be realized. In the ex-

Future Meetings of Other Societies

Society of Plastics Engineers, Regional Technical Conference, "Plastics for Building," April 3, New York, N. Y.

Air-Conditioning and Refrigeration Institute, Government-Industry Symposium, April 3-5, Commerce Department Auditorium, Washington, D. C.

SPI, 15th Annual Canadian Section Conference, April 4-5, Hotel Château Laurier, Ottawa, Ont., Canada

Refrigeration Service Engineers Society, Educational Forum, April 5-7, Sheraton-Palace Hotel, San Francisco, Calif.

ASME Meetings:

Instrument and Regulators Conference, April 7-10, Northwestern University, Chicago, Ill.

Spring Meeting, April 8-10, Dinkler-Tutwiler Hotel, Birmingham, Ala.

High Temperature Materials Conference, Cleveland Section High-Temperature Committee and Institute of Metals Division, April 16-17, Hotel Carter, Cleveland, Ohio

Gas Appliance Manufacturers Association, Annual Meeting, April 8-10, Greenbrier Hotel, White Sulphur Springs, W. Va.

National Electrical Industries Show, April 8-11, 71st Regiment Armory, New York, N. Y.

American Welding Society, Annual Spring Meeting and 5th Welding Show, April 8-12, Hotel Sheraton, Philadelphia, Pa.

Electronics in Industry, conference sponsored by Armour Research Foundation and IRE, April 9-10, campus, Illinois Institute of Technology, Chicago, Ill.

Radio Component Show, 14th Annual Exhibition, April 9-11, Radio & Electronic Component Manufacturers' Federation, London, England

National Nuclear Instrumentation Conference, joint ISA and University of Florida sponsorship, April 10-12, Atlanta, Ga.

Pennsylvania Electric Association

Meter Committee, Spring Meeting, April 11-12, Garden City Hotel, Garden City, L.I., N. Y.

Institute of Radio Engineers

9th Anual Southwestern Conference and Electronics Show and 2nd National Simulation Conference, Houston Section and PGEC, April 11-13, The Shamrock Hilton, Houston, Texas

Symposium on Telemetering, PGTRC, April 14-16, Philadelphia, Pa.

Role of Solid-State Devices in Electric Circuits, joint Department of Defense and PGCT-PIB, Engineering Societies Building, New York, N. Y.

Technical Conference and Trade Show, April 24-26, San Diego, Calif.

11th Annual Spring Television Conference, April 26-27, Engineering Societies Building, Cincinnati, Ohio

U. S. World Trade Fair and International Exposition, April 14-27, New York Coliseum, New York, N. Y.

10th Annual Conference for Protective Relay Engineers, April 15-17, Department of Electrical Engineering, Agricultural and Mechanical College of Texas, College Station, Texas

Systems for Information Retrieval, joint School of Library Science (WRU) and Council of Documentation Research symposum, April 15-17, Center for Documentation and Communication Research, Western Reserve University, Cleveland, Ohio

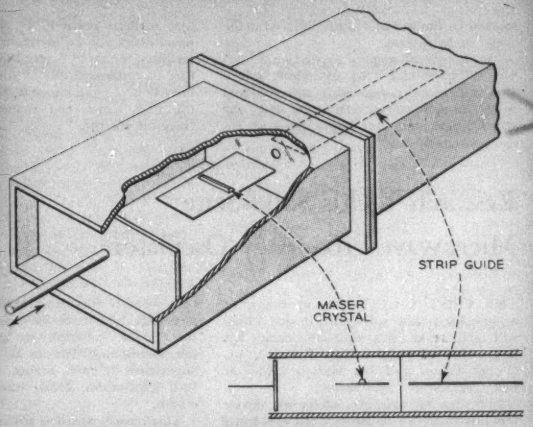
21st Annual Machine Tool Electrification Forum, April 24-25, Hotel Statler, Buffalo, N. Y.

National Industrial Research Conference, sponsored by Armour Research Foundation, April 24-25, Conrad Hilton Hotel, Chicago, Ill.

ASME, Railroad Conference, April 25-26, Sheraton Hotel, Chicago, Ill.

SMPTE, 81st Convention, April 28-May 3, Shoreham Hotel, Washington, D. C.

7th National Materials Handling Exposition, April 29-May 3, Convention Hall, Philadelphia, Pa.



SKETCH (above) depicts the resonant cavity and the crystal used in obtaining the first successful operation of a completely new solid-state device which will oscillate at microwave frequencies. The three Bell Telephone Laboratories scientists (photo *left*) whose work has resulted in a solid-state device which will oscillate at microwave frequencies are shown *(left to right)*: Harold Seidel, George Feher, and Derrick Scovil with their device, which is still in an early research stage.

periment conducted at Bell Laboratories, the energizing frequency was 17,500 mc and the signal frequency (in this case a self-sustained oscillation) was 9,000 mc.

Operating Conditions

A number of conditions have to be established before operation such as that described can take place. First, a single crystal of a solid-state material having certain specific characteristics is necessary. A whole group of materials, known as "ionically bound paramagnetic salts," appear to be suitable. After a careful survey, gadolinium ethyl sulphate was selected, although it is recognized that other compounds might perform as well or better for specific applications. Second, this material has to be diluted with an isomorphous diamagnetic substance to separate the gadolinium atoms sufficiently to reduce electron spin interaction. Lanthanum ethyl sulphate was selected, and it makes up about 99% of the finished crystal.

The crystal was mounted in a wave guide cavity having two resonant frequencies, one equal to the frequency of oscillation, and one the frequency of the energizing source. The sample occupied about 8% of the cavity volume, and was located at the point of maximum magnetic field intensity.

Low temperature operation is used so that power saturation of the crystal takes place with a reasonable amount of energizing oscillator power and also to increase the population difference between the energy levels. The sample and cavity were immersed in liquid helium at reduced pressure which provides a temperature of 1.2 degrees Kelvin.

To produce the necessary separation of the electron spin energy levels, a magnetic field is required. A value of 2,800 oersteds was employed in the device built at the Laboratories. This magnetic field may be altered to change the electron spin energies and, thus, tune the frequency of the stimulated radiation. The field must be properly aligned with respect to the crystal, and can be provided either by a permanent magnet or an electromagnet.

Equipment employed at the Bell Laboratories in demonstrating the operation of this new solid-state device included a wave guide cavity, with the crystal in place, immersed in liquid helium. This assembly was located in the field of a strong electromagnet. The 17,500-mc energizing oscillator signal was brought to the cavity through a rectangular wave guide, and the stimulated radiation of 9,000 mc was taken away by means of a strip guide mounted inside the rectangular wave guide. Measured power output was about 20 microwatts. Energizing oscillator power, which might be compared to "B+" power in a conventional amplifier or oscillator, was about 100 milliwatts to insure saturation of the crystal. Satisfactory operation can be attained with much less power.

Because of the very low noise factor which this device is expected to have, an improvement of several hundred times in sensitivity for a microwave receiver theoretically is possible.

By using the proper wave guide structure and by using an adequate amount of paramagnetic material, it is expected that sufficient gain can be achieved to realize the much greater advantages of the low noise figure.

Although the experiment as carried out produced oscillations at 9,000 mc, operation at both much lower and much higher frequencies is possible with proper choice of solid-state materials and operating conditions. Thus, the solid-state "maser" shows promise of being useful as a preamplifier in a wide variety of microwave applications.

Noise Barrier Ear Protector Guards Crews from Hearing Loss

A radically new "noise-barrier" ear protector—smallest, lightest, most flexible of its type—which will enable ground crews to work around jet engine aircraft without danger of hearing loss or ear damage, has been developed by the Radio Corporation of America (RCA), it was announced by the surface communications department, RCA Defense Electronic Products.

The ear protector was developed to meet a need for more effective and comfortable ear protection for ground crews and maintenance personnel at military and commercial airfields, particularly those with jet aircraft. This new device is capable of reducing highest jet engine noises to a safe hearing level.

Plans to begin commercial production of the lightweight ear protector early this year have been made by RCA. Resembling a set of ear phones, the RCA ear protector weighs less than 10 ounces and exerts only moderate pressure on the head. Despite the ultralightweight and pressure, the protector remains "sealed" to the head by automatically adjusting according to working position and movements.

This device represents a new design approach which combines fluid-filled sealing pads and a novel, simple self-adjustment feature to provide virtually universal fit and maximum noise-shunting protection. Unlike conventional types of ear protectors, the RCA development uses neither bulky absorbing material nor large sealing shells.

It was pointed out that hearing loss generally is induced by ambient noise levels approaching 130 db. Higher noise levels result in intense ear pain and possible damage to ear drums. Ground crews for jet aircraft, particularly, are required to wear ear protectors because of ambient noise levels which soar appreciably higher than 130 db.

Borazon, a Material Unknown in Nature, Scratches Natural Diamonds

TIME-HONORED belief that "only diamond scratches diamond" became obsolete when the General Electric (GE) Research Laboratory announced the discovery of an entirely new material never found in nature.

"Borazon," GE's name for this cubic boron nitride, scratches diamond with ease and remains hard at temperatures where diamond literally burns up, according to Dr. C. G. Suits, GE vice-president and director of research. He said the discovery can have "far-reaching impact on industrial processes and thus increase the value of products all of us will use in the future."

Dr. R. H. Wentorf, discoverer of borazon, recently demonstrated the scratch tests and other methods he has used to prove that the new material is "in the same general range of hardness as diamond and, thus, many times harder than the next-ranking materials in the hardness scale."

The 30-year-old Schenectady scientist was a member of the GE research team whose work resulted in the announcement of General Electric man-made diamonds two years ago. Wentorf said he uses similar techniques—combining tremendous pressures with high temperatures—to produce diamond-like crystals of boron nitride never before observed.

Is borazon harder than diamond? Wentorf cautiously guesses "it is about the same; borazon scratches diamond almost exactly as diamond scratches diamond—and diamond scratches borazon."

In actual lapping tests, borazon powder has polished away the surface of a large diamond at the same rate as diamond powder.

But in another important characteristic, borazon appears to be superior to nature's most glamorous substance. Diamond, being basically carbon, literally "burns up" in air at temperatures of 1,600 F. Borazon can withstand temperatures in the range of more than 3,500 F and thus should be better for many industrial applications.

"We believe borazon's resistance to oxidation will make possible superior methods of mounting stones in industrial tools and also may allow bits and wheels to be operated at higher speeds, performing their cutting and polishing job more quickly and efficiently," Dr. Suits said.

"What we are announcing now is not a product, it is a major scientific achievement—the creation of a new material never observed in nature, with properties equalling or surpassing those of a material long thought to be the 'ultimate', " Dr. Suits said, adding, "This work is an important step in General Electric's program of research aimed at producing the improved materials that will ensure tomorrow's progress."

The first borazon exhibited recently consisted of tiny crystals no larger than grains of sand, but even in this form the material is expected to be suitable for a variety of industrial uses. Dr. Wentorf says that the material is "generally black, brown, or dark red, although milky white, gray, and yellow crystals have been made."

Ordinary boron nitride is a white solid material similar in slipperiness, density, and crystal structure to black graphite. Boron and nitrogen "straddle" carbon in the periodic table of elements.

"Superpressures" above 1 million pounds per square inch and temperatures exceeding 3,000 F are used to produce crystals of boron nitride with a structure that is not hexagonal (like graphite) but cubic (like diamond). (Many substances—for instance, iron, sulfur, phosphorus, silica, or carbon—can crystallize in more than one form, depending mainly on the crystallizing pressure and temperature.)

X-ray diffraction tests of borazon reveal that the alternate atoms of boron and nitrogen are packed together almost as closely as the carbon atoms in diamond. The density is also about the same (specific gravity: 3.45 for borazon, 3.50 to 3.56 for diamond).

Electric Wristwatch First Change in 477 Years

A new era in timekeeping was ushered in recently with the introduction of the world's first electric wrist watch, perfected after 10 years of research, development, and testing by the Hamilton Watch Company, Lancaster, Pa.

No larger than a conventional wrist watch, the electric watch offers the highest accuracy and dependability ever achieved, and incorporates the first basic change in watch construction in almost five centuries.

The radical structure of the electric watch completely eliminates the mainspring, an integral part of portable timekeeping devices since it was invented in 1480 by Peter Henlein of Nuernberg, Germany. The new watch is the only one in existence which runs without winding or without periodic agitation.

The electric watch operates on chemical energy stored in a tiny energizer. This energy is converted into electric power as it releases a stream of electrons through a coil of fine wire fixed on a balance wheel. The electric energy, through interaction with permanent magnetic fields, causes the balance wheel to oscillate. This oscillation is the mechanical energy which runs the watch.

The over-all result is a precise miniature

GE Research Lab Photo

GE Research Lab Photo

CLUSTERS OF BORAZON (picture right) are weighed by the discoverer of the new material Dr. R. H. Wentorf (*right*). A. J. Nerad (*left*) is manager of the mechanical investigations section where "superpressure" research resulted in man-made diamonds and the new borazon. X-ray diffraction patterns (picture above) show that spacing of boron and nitrogen atoms in borazon (cubic boron nitride) is approximately the same as that of carbon atoms in diamond.

Hamilton Watch Co. Photo

MOVEMENT of the world's first electric wrist watch (top) is shown with movement of manually wound watch. The electric watch has 33-1/3 fewer parts. Large circle in left center of electric watch is energizer which replaces the mainspring.

power plant built into the balance wheel, which in turn moves the gear and the hands of the watch. In the past, the balance wheel only controlled the power furnished by a mainspring. In the electric watch it furnishes its own power as well as controls it.

The essential difference between this motor and the conventional electric motor is that the power plant, combined with a balance wheel, permits the flow of energy to be strictly controlled and the speed of the hands to be held to an accuracy of more than 99.995%. Combined with simplified construction and built-in shock resistance, the motor provides incredibly long life for a watch.

The coil is made of wire only one fifth the thickness of human hair. Enough of this wire for 1,000 watches would weigh only two ounces but would stretch from Dover, England, all the way across the English Channel and well into France.

The tiny magnets used in the electrical system are of platinum alloy and have the highest energy content of any magnet in the world today. They were processed by Hamilton expressly for use in the electric watch.

The Hamilton electric watch is more nearly free from disturbance by stray magnetic fields than any other watch and the television service man, a physician with an electrocardiograph, or any of the increasing number of people who work with or around magnets will be able to wear this watch with no interference.

Magnetic Tape Records SS Information

A roll of magnetic tape about the size of a dinner plate has replaced a 900-page report to speed the Social Security (SS) information of 80,000 General Electric Company (GE) employees from Schenectady, N. Y., to Baltimore, Md.

This latest application of automation principles to accounting marks the beginning of a new era of data transmission between industry and the Government, since this is the first application of the procedure.

According to the GE comptroller, the potential savings of such an operation are tremendous to both the Government and the company. GE employs more than 280,000 persons throughout the country and eventually it is expected that SS information for most of them will be forwarded by the tape method.

In addition to the saving in time and material for the preparation of these detailed SS records, there is also a huge saving in storage space required to keep the records.

This latest method of reporting such SS deductions to the Government was suggested by a procedures analyst in GE's data processing organization at Schenectady. It has received the approval of the Social Security Administration and the Internal Revenue Department.

The tape, which is approximately 2,400 feet long and weighs about two pounds, carried all of the quarterly SS report made for most of the GE employees in the Schenectady area. Until tape was used, it was necessary to prepare more than 900 typewritten pages, each containing 30 to 40 names, four times a year to supply the quarterly figures which the Government requires for Social Security.

Under the new procedure, data is fed into International Business Machines (IBM) computers for compiling GE payrolls and at the same time the special tape is run off for the Social Security Administration's records. The newly written tape is taken from the IBM *702* computer and put into a plastic bag which is sealed to keep the humidity constant during transmission to Baltimore, headquarters for Social Security Administration.

Running a payroll through the IBM machines for the GE employees in Schenectady requires approximately 28 hours, or about 3½ seconds per employee. This roll of SS tape is run off simultaneously. Eventually, the time may be chopped down to 2 seconds or less per employee.

When this 10½-inch roll of SS data tape is received in Baltimore it is put through a computer there and the earnings reflected in the data are credited to the Social Security accounts of the individuals listed on the tape from General Electric. Previously, it was necessary to punch cards for each individual name listed on the 900-odd sheets sent from Schenectady and then to put the cards through computing machines. The tape method eliminates the punching step in Baltimore, and cuts down on storage space.

The computer used in preparing the payrolls and for other accounting work is sheltered like a gilded lily in 2,400 square feet of space on the fourth floor of one of the company's office buildings here. The temperature is a vacationist's paradise—never less than 70 or more than 80 degrees—and the relative humidity is between 40 and 60. Three General Electric 10-ton unit air conditioners supply the filtered air to keep the computer in the proper atmospheric environment.

Scientists Develop Method of Taking Atomic "Pictures"

Scientists have perfected a new technique for taking pictures of the atomic "insides" of metals and other crystalline materials.

The technique was announced by Westinghouse. It employs a new means for detecting neutron "bullets" which are shot through the crystal. The process is several hundred times faster and more sensitive than previous methods, and promises to yield important new information about the atomic architecture of crystalline materials.

For years scientists have been using beams of high-power X rays to probe crystal structure. In passing through the crystal, the X rays are "scattered," or diffracted, by the atoms in the crystal. The X rays are then allowed to fall on a photographic film where they give a picture of the crystal's atomic arrangement. It is a fast, accurate, and extremely valuable research technique. More recently, with the advent of nuclear reactors, it was found that a beam of neutrons is diffracted in a similar fashion. What is more, neutrons will reveal the crystal structure of many thousands of different materials which are either impossible or impractical to analyze by X rays.

Until now, however, there has been considerable difficulty in getting a satisfactory picture of the diffracted neutrons. Exposures of many hours are required with standard sources of neutrons. The new technique shortens this exposure time as much as 100 times and is expected to extend considerably the usefulness of neutron diffraction for the study of crystal structure.

This neutron "picture-taking" technique was developed by Dr. K. H. Sun, in charge of the Westinghouse Radiation and Nucleonics Laboratory, and Miss Frances Pecjak, a member of his staff. The work was done in co-operation with Dr. W. O. Wollan of the Oak Ridge National Laboratory, Oak Ridge, Tenn.

Secret of the technique, Dr. Sun said, is an improved method for making the neutrons "visible" to a photographic film. As a result, the Westinghouse scientists have obtained the first neutron powder diffraction patterns ever known.

After being "scattered" by a crystal, the neutrons are allowed to strike a special fluorescent screen placed next to the film. The screen is made by imbedding a phosphor in a thin layer of special glass or plastic which contains atoms of boron. The neutrons pass through the photographic film and strike the screen, where they smash into the boron atoms. This releases tiny, powerful atomic particles which cause flashes of light on the screen. These flashes are "seen" and recorded by the photographic film, giving an exact picture of the diffracted neutrons.

It was explained that this round-about conversion of the neutron's energy to visible light is necessary because standard photographic film is "blind" to neutrons. The increased sensitivity and speed of the process over previous methods is due to the more efficient conversion of the neutron's energy.

Dr. Sun said the technique will also expedite the analysis of crystals of magnetic materials, which cannot be done with X rays. Unlike X rays, he said, neutrons are

tiny magnets. They interact with the bombarded atoms of a magnetic material and disclose its magnetic structure. This information is helpful in understanding the magnetic properties of materials and in designing new and better ones.

ARDC Tests Provide Information

A 43-year-old U. S. Air Force officer has reached an altitude of 198,770 feet—nearly 38 miles, in an aeromedical altitude chamber test.

It is the highest simulated altitude ever reached by man.

The Air Research and Development Command (ARDC) announced today that Major A. I. Beck reached the near vacuum in an altitude chamber at its Wright Air Development Center (WADC), Dayton, Ohio.

Major Beck, Brooklyn, N.Y., reached the record altitude while testing new equipment. He wore the recently announced *MC-4* partial pressure suit and pressure helmet to protect him during the record ascent. Without such protection a man would die from exposure to the low pressures which are encountered above 50,000 feet.

In making the run, the altitude rise was halted at 40,000 feet while adjustments were made to valves and suit. After a quick rise and pause at 85,000 feet, the chamber was dropped to 40,000 feet to dry up moisture that had accumulated. After a second rise to 85,000 feet and a drop to 40,000 feet, the run was started.

The chamber's simulated altitude rose quickly to 120,000 feet and then more slowly to the peak of 198,770 feet.

Major Beck was in charge of the test, but senior officer at "ground level" was Captain Terrence McGuire, Omaha, Nebr., who normally acts as medical observer during the chamber runs. Medical officer for the run was Captain F. J. Leary of Lincoln, Nebr. The chamber was operated throughout the run by Master Sergeant Bradford Moore, Cullman, Ala., senior airman in charge of the unit. All are assigned to WADC's Aero Medical Laboratory.

Major Beck had set 200,000 feet as his goal. The small, 50 cubic foot chamber on other occasions had gone to an altitude of 260,000 feet, but with no one in it. It was not expected that he could reach that fantastic altitude because of one physiological fact—he had to breathe.

Earlier, Major Beck had attempted to reach 200,000 feet, but each time he exhaled, his breath counteracted the near vacuum at full power and the observers were unable to raise the simulated altitude beyond 155,000 feet. At that altitude, the chamber's mercury gauge registered 0.9 millimeters, as compared with the 760 millimeters of mercury at ground level. This meant he was in an atmosphere of only 0.018 pounds per square inch pressure as compared with ground level pressure of 14.7 pounds per square inch.

For this latest test, a hose was run from his helmet's exhaust valve into an adjoining chamber, where the air he breathed out was dissipated. With this arrangement the chamber's mercury gauge was brought down to 0.250 millimeters (an atmosphere of only 0.0048 pounds per square inch) before evaporation of his perspiration halted the chamber's ascent.

The emergency partial pressure suit for high altitude flight already has been used successfully for several record flights. It was used by Air Force pilots flying the *X-2* rocket research aircraft to altitudes never before reached by man; and it was used by two U. S. Navy officers who recently set a balloon altitude record of 75,000 feet. Worn by ARDC Major Beck to an altitude of 198,770 feet, the new suit will replace the Air Force's present *T-1* suit because it is more comfortable, and provides more protection and mobility.

The suit gains its comfort and mobility from an improved design. While still tight fitting, it is looser than the *T-1*. With only 12 standard sizes almost any man can be fitted perfectly. This is accomplished by two sets of lacings down the front, which can be tightened or loosened to mold the suit to the contours of the man's body. The result is a garment that permits almost normal breathing. In the *T-1* suit, an airman has to learn reverse breathing—that is, he had to exhale forcibly while allowing the pressure of the oxygen system to force his inhalations.

Because of this improved fit, and resultant comfort, a pilot can wear the new suit longer, either uninflated or inflated. The suit also can be donned and removed without assistance. The *T-1* required a "helper."

In the assembly, which includes a pressurized helmet, all electrical leads (including communications) are carried in one small hose. One version, the *MC-3* is designed for bomber crewmen, while the *MC-4* has a built-in antigravity suit for fighter pilots. Both also include pressurized gloves.

The suit is made of toughened material that needs little maintenance, lasts longer and, thereby, reduces the number of replacements. An undergarment, it is worn over underwear and can be covered with light coveralls in the summer or warm outer garments in the winter.

The two men who directed the partial pressure suit project were Captain McGuire and C. C. Lutz of St. Paris, Ohio. who is one of the engineers in the Respiration Section of WADC's Aero Medical Laboratory. Mr. Lutz was one of several men who reached an altitude of 106,000 feet in the *T-1* suit several years ago. Captain McGuire recently won second prize in an Air Force Association Science Symposium for his paper on partial pressure suit studies.

Test Missiles Save Taxpayers' Money

Two ingenious research missiles, especially designed to combine highest performance with low cost, are saving U.S. taxpayers millions of dollars as the nation's missile program moves forward, the U.S. Air Force (AF) revealed.

Designated the *X-7* and the *X-17*, the test "birds" go through the paces of regular operational missiles. However, the *X-7* ramjet vehicle is recovered from supersonic flight by parachute to fly again, and its big brother—*X-17*—is only a fraction as expensive as the long-range ballistic missiles it simulates.

Maj. Gen. B. A. Schriever, head of the Western Development Division of the AF's Air Research and Development Command (ARCD), told a meeting of the Institute of Aeronautical Sciences that both are being used by the AF to push forward missile programs at important savings of time and money.

The *X-7* saves taxpayers about $350,000 with each recovery and reflight. Officials of Lockheed's Missile Systems Division, which builds both missiles in its Van Nuys, Calif., plant, say that the AF by its use of the *X-17* saves "literally millions" in this program.

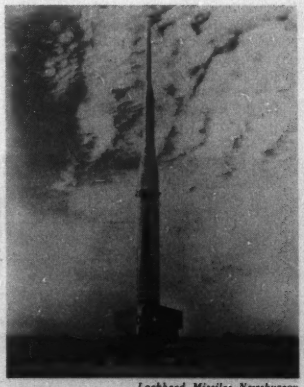
The *X-17*, itself a three-stage ballistic rocket which weighs more than six tons and stands as high as a four-story building, is nonetheless inexpensive as compared to full-scale operational missiles. This rocket is used to provide information on the problems which arise when the warhead of a ballistic missile re-enters the earth's atmosphere at high speed. The use of a full-scale missile would be much more expensive.

The full story of this highly successful re-entry test vehicle cannot be told because its flights are providing data of considerable military significance which must remain classified.

The AF previously disclosed that its ballistic missile program encompasses the efforts of some 17 aircraft and scientific companies.

At that time, it described the *X-17* rocket as a "key link" in the vital ballistic missile program which includes the intercontinental vehicles *Atlas* and *Titan* and the intermediate range missile, *Thor*.

To obtain data on the re-entry problem,



Lockheed Missiles Newsbureau

THE LOCKHEED *X-17* test missile points skyward as it is readied for flight at Patrick Air Force Base. A three-stage rocket, as high as a 4-story building, the X-17 weighs more than six tons.

Lockheed scientists launch the *X-17* from Patrick Air Force Base, Florida, which is the AF's long-range missile firing area. The test missile hurtles out through the earth's atmosphere at speeds far in excess of the velocity of sound. Within seconds after it is fired the missile blasts through the sonic barrier and pierces the ionosphere—a layer of very thin air starting some 50 miles above the earth and extending to about 250 miles. Missile scientists designed the vehicle to plunge at tremendous speeds from the ionosphere back into the earth's heavy blanket of air.

Diesel Power Plant Thinks for and Operates Itself

A completely automatic diesel power plant which thinks for itself, turns itself on and off, sends signals about operating conditions to technicians in a control center miles away, and operates without manpower in attendance has been developed for use in radar systems in the United States.

Designed by Consolidated Diesel Electric Corporation (Con Diesel), the equipment Con Diesel's Model *4,000*, features an electronic "brain" and built-in "memory system." The completely automatic power package is manufactured by Con Diesel's Power Equipment Division for use as a primary power source for four fifths of all unmanned radar installations in the nationwide SAGE (semi-automatic ground environment) system.

The compactly packaged primary power units are designed for gap-filler radar stations—which cover gaps between main and auxiliary radar installations because of uneven terrain and other reasons. The equipment powered by the Model *4,000* provides a fence or alarm system between main and auxiliary stations.

Because radar installations are designed to operate from commercial power supplies and lines where available, the power plants will stand in reserve or be used as a source of auxiliary power in regular operation. Normally, the power plant will include two diesel generator sets and a "brain" or power supply control. Each is completely automatic, designed to operate without personnel in attendance.

In the event the normal power supply from commercial lines fails, weakens, fluctuates, or otherwise ceases to provide steady and sufficient power for radar operation, the automatic power plant turns itself on and provides power to the full load in less than 12 seconds.

If, for example, one diesel generator set of the power plant ceases to operate at full capacity or fails because of insufficient lubricating oil—or any other malfunction—the second unit automatically turns itself on and assumes the load.

At the same time, the inoperative unit returns itself to the standby position, turns itself off and relays back to the main control plant that it has failed and the reason for the failure.

The "memory system" which records control or mechanical deficiencies or failures in the units, indicates to technicians at the control point what repairs are necessary and what parts need adjustment or replacement.

As an extra precaution the power plant makes an automatic two-hour check of the commercial power supply voltage after this voltage has returned to the correct range. If the commercial voltage remains within established limits, the unit returns the radar equipment to commercial power, shuts itself off, and returns to standby condition.

Automation of the Model *4,000* frees personnel and allows the radar line to be operated with a minimum of trained technicians, at the same time decreasing the chance of human error.

Plastic Pump Conveys $FeCl_3$ with Printed Circuit Production Line

Printed circuitry, having solved many production and cost problems in the television and radio manufacturing field, has imposed some new ones which the electronics industry has found difficult, if not impossible, to solve. One of these is maintaining steady operation of pumps conveying ferric chloride ($FeCl_3$) for printed-circuit etching. Warm concentrated $FeCl_3$ is highly corrosive to metals and causes leakage through the packing of conventional pumps.

Concentrated $FeCl_3$ dripping through stuffing boxes or mechanical shaft seals, crystallizes with the unhappily frequent results of costly breakdowns while the pumps are replaced or repaired.

Such was the actual case at the radio and television manufacturing plant of the Westinghouse Electric Corporation in Metuchen, N.J., as reported recently to the Vanton Pump & Equipment Corp. in nearby Hillside, manufacturers of plastic pumps without stuffing boxes or shaft seals of any sort.

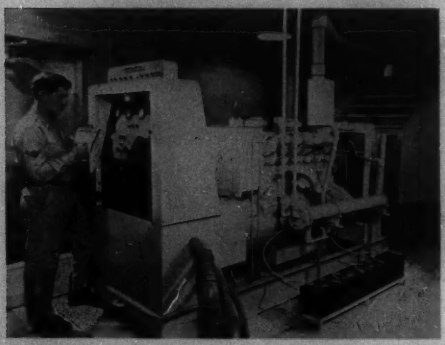
Basically, the printed circuit process at Westinghouse consists of silk screening circuit diagrams with acid-resistant ink on base boards which are then conveyed into spray-etch chambers. The excess copper foil not protected by the resistant ink is etched away by the warm concentrated $FeCl_3$. Vapor degreaser is then applied to remove the acid-resistant ink, exposing the remaining copper circuit.

The problem had been frequent breakdowns of the three conventional pumps in use to convey $FeCl_3$ continuously from overflow reservoirs providing a supply of fresh liquor to the spraying system.

Three sealless pumps were recommended with a capacity of 5 gallons per minute each. These had no stuffing box or mechanical seal and were self-priming. The fluid was in contact only with the inner surface of a Bakelite housing and the outer surface of a natural rubber "flex-i-liner" insuring complete resistance to the chemical action of $FeCl_3$.

In addition to eliminating the problem of corrosion, maintenance was reduced to the infrequent and simple replacement of the inexpensive liner. The three pumps stayed in operation continuously for 12 hours a day.

The dangerous $FeCl_3$ flows in a channel between the molded plastic body and the natural rubber flex-i-liner. No liquid touches metal. Flanges on the flex-i-liner straddle the pump body block and are pressed to its sides by bolted face plates, thus forming the isolated fluid channel. The pumping mechanism is a rotor mounted on an eccentric shaft which, at each revolution, pushes the flex-i-liner against the body block and sweeps a "slug" of $FeCl_3$ around a circular track from inlet to outlet. All bearings are life time permanently lubricated ball bearings completely out of fluid area and further protected in a stainless steel assembly.



MODEL *4,000* generator set, designed around an electric "brain," permits operation at remote installations. Air Force technicians (shown) visit such sites periodically to observe and record operating characteristics.

Electronic "Ear" Selects Human Voice from Noise

An improved electronic "ear" that automatically selects the human voice from any background noise, permitting telephone conversations to ride effortlessly above unavoidable line static has been announced by Federal Telecommunication Laboratories (FTL), Nutley, N. J., a division of International Telephone and Telegraph Corporation. FTL developed the voice-saving "compandor" as a solution to the myriad causes of electrical telephone interference.

The compandor compresses the volume range of the speaker's syllables for transmission and raises them above the level of the background noise. For reception, the noise between syllables is eliminated and the original volume range of the speaker's voice re-

stored. The system name is derived from the "compressor" and "expandor" functions of the equipment.

The most pronounced effect of the compandor is the elimination of the masking of low volume consonant sounds by the circuit noise, permitting the listener to differentiate clearly between words having similar vowel patterns.

By improving the effective signal-to-noise ratio, the compandor permits the use of direct wire and radio links that would not otherwise have the desired transmission qualities. The sharp increase in telephone traffic in recent years has resulted in electrical interference that could be overcome only by expanding existing facilities or the addition of amplifiers at frequent intervals.

The compandor can be produced inexpensively, because the nonlinear elements it employs to achieve variable gain characteristics are fewer in number than other similar devices, and because of special circuitry, need not be selected and exactly matched.

NSC Asks What You Need

As the National Safety Council's Electrical Equipment Section's executive committee starts another year of activity, its major concern is how it can be of greatest service to all.

Obviously, it can be of most help in fulfilling the greatest needs. But, they have to know what these needs are. That is where others come in. Consider these questions:

1. What additional technical helps do you need that might be developed by the Research and Engineering Committee?
2. What kind of information are you most interested in getting through the newspapers?
3. What subject would you like to have discussed at the next National Safety Congress?
4. Is there anything else that you feel the section's executive committee or the National Safety Council staff could do to be of further assistance to you in your accident prevention efforts?

Think it over and drop a note to C. F. Schlueter, general chairman, in care of Employers Mutuals, Wausau, Wis.

Intercontinental Strategic Guided Missile

Flight testing of North American Aviation's *X-10*, an unmanned test vehicle for the U. S. Air Force (USAF) *SM-64* NAVAHO intercontinental strategic guided missile program, has been concluded by the company's Missile Development Division, and initial operations begun on the *XSM-64*, it was announced recently.

Called "an invaluable source of important data" by Maj. Gen. B. A. Schriever, who heads the USAF's Western Development Division, Air Research and Development Command (ARDC), the *X-10* is powered by two turbojet engines and is provided with a landing gear so that it can be recovered for repeated use.

The *X-10* has successfully been flown hundreds of miles at supersonic speeds, it was stated. The purpose of the test program was to prove out the missile's aerodynamic design as well as its guidance and control systems. Final flight testing was undertaken at the USAF Missile Test Center, Florida.

Work on the major phases of the NAVAHO weapon system program was begun in 1945. The first test phase was conducted on the

X-10, unmanned test vehicle for the U. S. Air Force SM-64 NAVAHO intercontinental strategic guided missile weapon system program.

NATIV, a 14-foot test vehicle, with the second research and development phase accomplished through *X-10* flights.

Design and manufacture of the NAVAHO guidance and control systems is the responsibility of North American's Autonetics Division, and a third division, Rocketdyne, is building rocket engines for the missile, which will be rocket boosted to flying speed and then powered by ram-jet engines. The NAVAHO will travel at supersonic speeds and very high altitudes, with a delivery accuracy not provided for in any other type long-range surface-to-surface missile.

Nuclear Powered Miniature Battery Developed

The development of a miniature nuclear-powered battery capable of delivering continuous electrical power for at least five years has been announced recently by the Elgin National Watch Co.'s Walter Kidde Nuclear Laboratories.

The battery, approximately the size of the head of a thumb tack, has a nominal power output of 20 microwatts and is the first such device to be completely safe for extensive personal use without special precautions, according to its inventors. The battery utilizes the decay energy of a beta-emitting radioisotope as its source of energy.

Operation of the battery depends upon a two-step conversion of energy: from beta emissions to light and from light to electricity. The light source consists of a mixture of finely divided phosphor and an oxide of promethium-147, one of the most abundant nuclear fission products. Beta particles emitted by the promethium are absorbed by the phosphor and converted into red and infrared light. This light is captured by two or more photocells and transformed into electric current.

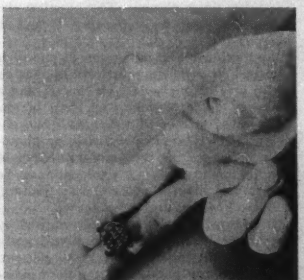
Although not yet commercially available, the battery eventually will be used in such products as hearing aids, miniature portable radios, and civil-defense warning receivers for the home. It has been predicted that the battery will some day be used for an atomic-powered wrist watch. In such an application, the power unit would be as safe as modern radium-treated wrist watch dials.

Additional use for the atom cell in military high-altitude missile and rocket work and in scientific deep space experiments is also foreseen. In contrast to conventional batteries, the nuclear source operates satisfactorily at extremes of environmental conditions. At temperatures as low as 200 F below zero, voltage and power output actually increase. At temperatures up to the boiling point of water, the cell operates with a small decrease in power output.

The prototype battery uses about 4.5 curies of promethium-147, a radioactive element with a half-life of 2.6 years and maximum beta energy of 0.223 MEV (million electron volts). This has a weight in the form of the oxide, Pm_2O_3, of only 5 milligrams. With this amount of activity the battery has a nominal power output of 20 microwatts when new, 10 microwatts after 2.5 years, and 5 microwatts after about 5 years. Greater power outputs can be obtained by connecting a number of cells in series or by building cells of larger area.

In the prototype, Pm_2O_3 is applied as a coating on the phosphor particles and the entire light source is sealed in a transparent container of radiation-resistant plastic. Photocells are silicon cells of the solar type, specially modified to give maximum efficiency at the light levels at which the cell operates. The present cell is housed in a compact metal protective shielding that leaves the complete unit about the size of a cough drop.

A basic advantage of the two-step energy conversion, according to Dr. Philip Miller of Walter Kidde Nuclear Laboratories, is that the sensitive photocell is protected from the direct beta radiation of the radioisotope. Such radiation, a problem in pre-



W. Kidde Nuclear Lab Photo

NUCLEAR MAGIC compared with man's fingers which loom large holding the tiny atomic-powered battery. In shielded form shown, it is no bigger than a cough drop, yet capable of delivering usable electric current for as long as five years.

vious attempts to develop a nuclear source of this kind, produces crystal defects in the semiconductor material of which the photocell is made and causes its efficiency as an electrical generator to decline rapidly.

In the present battery, only the phosphor is subjected to beta radiation, to which its resistance is relatively high. Any beta particles not absorbed by the phosphor are absorbed in the plastic case of the light source, which is also radiation-resistant.

According to Dr. Miller, promethium was selected for the power source after a study of the various available radioisotopes because it combines a number of favorable properties for a battery of this size and power level. Primary gamma radiation is absent, and the relatively low energy of its beta radiation allows all of its energy to be absorbed in a layer of phosphor having a weight of only 50 milligrams per square centimeter (approximately 0.005 inch thick).

As received from Oak Ridge National Laboratory, promethium is in an impure condition and one of the impurities, europium, emits gamma radiation. The promethium is highly purified not only to eliminate the source of gamma radiation but also because any other impurities decrease the efficiency of the light source.

In its purified form the promethium contains no significant amount of gamma emitters; however, the light source is a source of a minor amount of secondary gamma radiation known as Bremsstrahlung, generated when beta particles are absorbed by matter. For some uses, this radiation requires no shielding of the battery. For extended personal use, the battery is made entirely safe by sealing it in a small case of dense metal such as Hevimet, Tantalum, or Mallory metal. The outside dimensions of such a shielded battery are 0.2 inch thick and 0.6 inch in diameter.

Cell design also involved the choice of a suitable particle size for the phosphor. There is some loss of light due to the partial opacity of the phosphor, and this increases as the particles are made finer. On the other hand, finer phosphors tend to be somewhat more efficient. The practical size range was found to lie between 10 and 50 microns.

Approximately 50 milligrams of phosphor are used in the light source, which has an active area of one square centimeter and a diameter of 7/16 inch. Each face of the light source is covered either with one circular photocell or two semicircular photocells. By connecting the photocells either in parallel or in series the voltage may be varied from about ¼ volt to 1 volt, the total power remaining unchanged.

It is important that the light emitted by the source be in a range of wave lengths at which the photocell is most efficient. Practical silicon photocells have their maximum power efficiency for light in the region of from 6,900 to 8,200 angstroms, and accordingly phosphors containing cadmium sulphide or mixtures of cadmium and zinc sulphides were used, since these emit strongly in this region. These phosphors give off red and infrared light, and while they are less efficient in the visible range than the more widely used green phosphors, the silicon cell is efficient in capturing their invisible radiation as well as the visible light.

While promethium-147 is presently available only in limited quantities at relatively high cost, the Atomic Energy Commission has indicated that the element will be available in large quantities at a cost of approximately 50¢ per curie when a new plant now under construction goes into production.

Marker Shows First Long-Distance Transmission

Two historical roadside markers were installed in December 1956 near Anderson, S.C., calling attention to the vicinity as being the place where the first successful long-distance transmission of electricity for commercial purposes occurred in the United States.

According to the Anderson, S.C., *Independent*, the town's growth was handicapped by the higher cost of electricity made by the inefficient steam power of the late 1890's. A native son, W. C. Whitner, an engineering graduate of the University of South Carolina in 1886, encouraged the formation of the Anderson Water, Light and Power Company. In 1895, electricity was generated by water power at High Shoals on Rocky River, six miles east of Anderson. It is claimed that this was the first long-distance transmission in this country and that the a-c generator was the first to be built and operated at 5,000 volts.

Upon the success of High Shoals, a dam and power plant was built at Portman Shoals on Seneca River, 10 miles west of Anderson, where power was generated at the then unheard of voltage of 10,000, and transmitted the 10 miles to Anderson. It marked the transmission of power on the longest lines in the United States and it was the first commercial plant to employ so high a voltage. This plant has been in continuous use since 1897 and is now owned by the Duke Power Company.

The original equipment for the High Shoals plant was built by the Stanley Electric Company, whose physical properties were acquired by the General Electric Company. There were two 720-kw generators operating at 10,000 volts, 2 phase, and 66⅔ cycles.

Symposia To Be Held on Topics of Varied Interest

Systems for Information Retrieval. The School of Library Science of Western Reserve University, in conjunction with its Center for Documentation and Communication Research, will present on April 15-17, 1957, the nation's first comprehensive demonstration of systems presently in use for the organization, storage, and retrieval of recorded information, together with a symposium on information-handling problems and techniques.

Cosponsor of these activities is the Council on Documentation Research, a group recently formed by representatives of organizations in Government, industry, and education for the stimulation of effective co-operation among those who produce, organize, and use information of all types in all fields.

An outgrowth of the Conference on the Practical Utilization of Recorded Knowledge held in Cleveland, January 1956, this three-day program will bring together 20 or more information systems devised or adapted by their users to meet specific problems. Machines needed to make the presentations most effective will also be demonstrated, but the emphasis is to be on working systems. Further information may be obtained from: J. H. Shera, Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

Nondestructive Tests in Nuclear Energy Field. A symposium on "Nondestructive Tests Developed in the Field of Nuclear Energy" will be held at the Morrison Hotel in Chicago, Illinois on April 16-18, 1957. This symposium is cosponsored by American Institute of Chemical Engineers (AIChE), American Nuclear Society (ANS), American Society for Testing Materials (ASTM) and Society for Nondestructive Testing (SNT).

During the past 15 years various Atomic Energy Commission laboratories and contractors have been carrying on extensive research and development programs in the nondestructive testing of nuclear reactor components, especially fuel elements. In this period, a considerable amount of technology for the testing of nuclear reactor fuel elements and other components has been accumulated. The purpose of this symposium is to present declassified information on testing methods and techniques used.

The information to be presented at the symposium will be of interest to (1) industrial groups already engaged in reactor design and construction, (2) industrial groups contemplating work in the reactor field, and (3) industrial groups in other fields of endeavor who can use many of the methods and techniques developed.

Role of Solid-State Phenomena in Electric Circuits. The seventh of a series of International Symposia sponsored by the Microwave Research Institute of the Polytechnic Institute of Brooklyn will be held on April 23-25, 1957, in the Auditorium of the Engineering Societies Building, 33 W. 39th St., New York, N.Y.

This Symposium will cover the more recent developments in the application to electrical circuits or systems of the more unusual or unexploited physical effects in solids. It is being held because of the ever increasing importance of solid-state effects in the simplification of circuit functions and electronic apparatus leading to decreased size and increased reliability.

The major area of interest lies in effects which provide for new or improved electronic devices functioning as generators, amplifiers, detectors, measuring instruments, components, etc. There also is interest in new circuit responses not heretofore readily obtainable, such as the nonreciprocity provided at microwave frequencies by ferrites, or the possibility of a solid-state negative resistance diode.

Physical Problems of Color Television. An International Symposium on Physical Problems of Color Television, organized by the International Union of Pure and Applied

Physics and sponsored by UNESCO will be held in Paris, France, July 2-7.

Sessions will be devoted to: (1) properties and behavior of the human eye in color television; (2) image analysis and restitution, pick-up tubes, and color kinescopes; (3) assessment and measurement of picture quality; and (4) coding procedures for transmission of color signals. These topics will provide to physicists, electronics, optics and television specialists, an exceptionally full and convenient opportunity of gathering and comparing data relating to the many physical problems which are met in the study of color television and the design of color television apparatus.

For any additional information, apply to The Secretary: Colloque International sur les Problèmes de la Télévision en Couleurs Conservatoire National des Arts et Métiers 292, rue Saint-Martin, Paris 3ème, France.

Contributed papers on all relevant subjects will be considered and the agenda extended, if necessary. Papers intended to be read during the symposium should be submitted to the committee in title and in abstract at a date prior to May 1st, 1957. This will permit printing and circulating a complete list of abstracts to all participants by June 1st, 1957. Abstracts should be prepared according to the directions of the UNESCO "Guide for the Preparation of Authors Synopses." (Copies of this document will be sent on request.)

Papers may be read and be commented upon by their authors or their delegates in any languages they may prefer, though the use of either French or English is recommended. Time alloted for the reading of each paper: 30 minutes, followed by a 15-minute discussion period. The chairman of each session shall have authority, after consideration of the final agenda, to extend discussions if considered expedient.

Invited papers are permitted 45 minutes.

Experimental demonstrations during the meeting will give broadcasts of color television programs using various existing systems. The committee will endeavour to provide facilities for authors who wish to present and demonstrate measuring apparatus at the meeting.

Technical visit and excursions will be arranged for participants of the symposium.

Subscription to the symposium will be about 1,500 French francs for each participant. Participants are requested to send notice of their intention to attend to the Committee.

Forces between Atoms Studied by Use of "Whiskers"

One of modern science's oddities—highly pure and perfect metal crystals known as "whiskers"—are enabling scientists at the Westinghouse Research Laboratories, Pittsburgh, Pa., to gain new insight into the enormous forces which bind atoms together.

During the seventh New York meeting of the American Association for the Advancement of Science at the Hotel Martinique on December 29, Dr. R. L. Eisner, Westinghouse research physicist, described a new technique for evaluating these forces by measuring the tensile strength of whiskers of iron and silicon.

Dr. Eisner's technique is one of the most accurate methods known for pulling apart the tiny crystals and measuring directly the applied stress and the amount of strain they undergo. Precise, delicate equipment is required, Dr. Eisner said, because the tiny strands of metal may be 40 millionths of an inch or less in diameter—about 0.01 the thickness of a human hair. Use of the method has cast new light on the nature of the interatomic forces which give all metals their ultimate strength.

"In whiskers, a metal exists in a perfect condition," Dr. Eisner said. "In contrast, any ordinary piece of metal contains countless millions of structural imperfections. Under stress, it is these imperfections which govern how and when the metal will break. They mask any attempt to measure the much larger forces which hold the metal atoms themselves together.

"By conducting tensile tests on whiskers, where these imperfections do not exist, we can pull the individual atoms far enough apart, without breaking, to get a measure of the interatomic forces. This enables us, for the first time, to check modern theories of interatomic forces."

In Dr. Eisner's "whisker" experiments, only a small force—less than 0.01 of an ounce—is required to pull the average whisker apart. This force, which must be controlled and measured with unusual accuracy, is obtained by a lightweight pendulum about 12 feet long. The whisker is "clamped" between the bob of the pendulum and a special "take-up" screw. As the screw is tightened, the whisker pulls the pendulum from its vertical position. Each millionth of an ounce of pull displaces the handling pendulum exactly the same amount—about 0.0001 of an inch.

The stretch of the tiny whisker is measured by reflecting a beam of light from flat optical mirrors attached to the clamps at each end of the whisker, to form an "interference pattern." As the whisker stretches, the mirrors move and cause changes in the pattern similar to the changing "rainbow" colors seen in soap bubbles or thin films of oil. These changes are electronically amplified and analyzed to disclose the amount of stretch. The technique accurately measures changes in whisker length down to less than 0.000001 of an inch.

These experiments have revealed considerable data about interatomic forces. It has been found that, freed of the limitation imposed by impurities and imperfections, these forces give iron a strength of more than 500,000 pounds per square inch.

Whereas in ordinary steel imperfections cause it to flow and deform at a tenth its ultimate strength, no such "plastic" deformation has been found when interatomic forces only are involved. Even the elastic limit of "soft" metals such as tin in the perfect structural state is at least 10 times the maximum in the best steels.

Graduate Courses in Nuclear Science and Engineering

Nuclear science and engineering is now a major educational and research activity at Rensselaer Polytechnic Institute (R.P.I.), Troy, N. Y., Pres. L. W. Houston said in comment on a special graduate bulletin which has just been published to describe the full program.

The program comprises a series of 16 graduate courses, covering key technical areas of nuclear work. They include both introductory and advanced nuclear courses in reactor physics, in metallurgy, heat transfer and thermal stress analysis, chemistry, and chemical engineering. There are also single courses in nuclear reactor control, radiation biology, management of atomic operations, geology, and finally a "capstone" course that develops complete power reactor projects under the guidance of several instructors. A number of these courses combine laboratory experiments with the lecture series.

The R.P.I. approach to nuclear training is unique in that there is no separate department of nuclear engineering. Instead, the nuclear teaching is integrated with the academic offerings of 10 existing science and engineering departments.

This approach is believed to be more effective in developing the large variety and number of specialists, including physicists, chemical engineers, metallurgists, and many others, on whom the nuclear power industry must depend. Dr. V. L. Parsegian, chairman of the R.P.I. Engineering Faculties and also Professor of Nuclear Engineering and Science states:

"For example, a metallurgist can make his best contribution to the nuclear field by taking his master's or doctoral degree within the department of metallurgical engineering. In this way, he would combine essential non-nuclear courses with three to five courses selected from the nuclear series in order to prepare to do metallurgical work corresponding to the advanced degree properly."

The nuclear series is designed to have flexibility. A graduate student registered in any department can select the sequence of introductory and advanced nuclear electives which will best prepare him for the work he wants to do.

There have been approximately 400 registrants for these nuclear courses during the current school year. Nearly half have been scientists and engineers of the Knolls Atomic Power Laboratory, operated by the General Electric Co. for the Atomic Energy Commission (AEC), which is engaged on several major reactor projects.

Development of the nuclear courses has benefited greatly from a co-operative program with the Knolls Laboratory. This year R.P.I. has assumed responsibility for providing all the advanced nuclear courses, eight in number, to the working staff of the Laboratory. The principal staff of that Laboratory, and the AEC have been very helpful in aiding this development. Co-operative programs with ALCO Inc., Combustion Engineering Co., and United Aircraft (Pratt & Whitney) have also been developing.

The educational work has also been very greatly supported by the wide range of nuclear research programs which are under way at the Institute.

R.P.I., the oldest engineering college in the United States, is also pioneering in this vast new atomic technology.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Computer Power Generation

To the Editor:

Your December 1956 issue has just reached me here at Pearl Harbor, Oahu, T. H., and after reading the article "Power Generation and Distribution at Air Defense Computing Centers," I was quite concerned with the engineering used in designing the "economical plant with continuity of power as the objective." The "some growth in electronic equipment" is assumed to be all-inclusive and will effect a load of 860 kw simultaneous with the peak demand. Does it not seem reasonable that there should be a diversity factor applied to each of the eight loads that you indicate as adding to the 2,600 kw that constitute the peak? Our experience indicates that various loads on this type should have a diversity factor to the power plant bus of about 3 or 3.5 to 1. Some engineering contractors have used a factor of 1.7 to 1 but it is not substantiated by actual measurement. It is my opinion that by using a diversity factor of 2.5 to 1 the estimated demand would be closer to the measured demand. Your Fig. 2 shows that the loads listed are separate loads and are not their contribution to the peak load. If all loads other than the electronic equipment load are applied, a diversity factor of 2.5 then added to the 860 kw, the peak load at the power plant bus would be 1,544 kw. The calculations shown in the article would only be correct if the loads shown were all at full load at the time of the peak, which is doubtful. The article indicates that there is diversity between summer loads and winter loads and there certainly is some between day shifts and night shifts, and Sundays, holidays, and normal work days. The calculations shown indicate that three 650-kw units would carry the peaks. Since the 650-kw unit has been selected as the proper size, this would indicate a minimum daily load of something less than 650 kw and a very bad load factor.

Under the "Conclusions" of the article, it is stated that "a power plant has been planned that is economical" which should result in "providing uninterrupted power to at least one of the two identical computers." Spinning reserve is only necessary to provide for the capacity of one computer where no interruption to service is permitted, whereas the spinning reserve as calculated consists of one unit above the peak load of 2,600 kw and not one unit above the minimum requirement to operate one complete computer and necessary auxiliaries. Where there are interruptive loads being carried on the peak and where a standby unit is also provided, it does not seem that spinning reserve would be required. A footnote states that the research in this document was jointly supported by the U.S. Army, U.S. Navy, and U.S. Air Force, but I am wondering if this type of engineering is considered by them to be economical.

Very truly yours,

JOSEPH M. LYND (AM '48, M '55)

(Past Chairman, Hawaiian Section)

To the Editor:

This is in reply to J. M. Lynd's letter of January 7 to you in which he questions the economics of the generating plants as described in my article, "Power Generation and Distribution at Air Defense Computing Centers." I believe a careful reading would indicate that the only purpose for the existence of the power plant is the generation of power for the computers which must operate without interruption. All other loads are subservient and their duty cycles do not resemble the usual industrial or commercial applications. Of the eight loads itemized in Table I, all but that consumed by electronic-maintenance equipment and lighting are mainly a function of the electronic equipment load. Because the two computers are operating 24 hours a day, day after day and week after week, the electronic equipment load is relatively constant. The motor–generator losses are determined by this constant load. The telephone equipment which brings data into the computer is also constant. The refrigeration and cooling equipment have been installed to cool the highly concentrated electronic load. The variation in refrigeration load is a result of the outside temperature and humidity. The lighting and maintenance loads will not change appreciably because the building is windowless and is manned by military and civilian personnel around the clock, every day. The diversity factors which have been applied to each of the itemized loads are very close to 1.0. The powerhouse auxiliaries will consume a somewhat constant load because the power plant is supplying a fixed load.

An extra diesel generator is connected to the bus as "spinning reserve" because there is no published data on the unexpected loss of a diesel. It is connected chiefly to assure sufficient generating power should one diesel fail, and not to provide for variations in load.

Very truly yours,

J. J. GANO (M '53)

(Massachusetts Institute of Technology, Lincoln Laboratory)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

AMERICAN POWER CONFERENCE PROCEEDINGS, VOLUME XVIII, 1956. Illinois Institute of Technology, Technology Center, Chicago 16, Ill. 665 pages, 9¼ by 6 inches, bound. $8. The present volume of this annual publication features a nuclear energy forum at which some of the broader aspects of nuclear power development were considered: the role of industry and of Government, research tasks, etc. The papers delivered at the regular sessions—mechanical, electrical, nuclear energy, and water technology—are devoted to a wide range of subjects, including supercharged boiler design, fly ash and slag, air pollution, high-temperature, high pressure power generation, 300–3,000 cycle power in industry, digital computers for power system analysis, and ion exchange membranes for water conditioning. Various aspects of corrosion are treated in a group of five papers delivered at a special symposium.

ANNUAL REVIEW OF NUCLEAR SCIENCE, VOLUME 6. Edited by J. G. Beckerley and others. Annual Reviews, Inc., Palo Alto, Calif., 1956. 471 pages 6 by 9 inches, bound. $7. The present volume contains reviews of advances, and of the literature on 13 topics. One of the papers deals with reactors for power generation, the remainder with such specialized subjects as time variations of primary cosmic rays, nuclear radiation effects in solids, low-level counting techniques, and applications of oxygen isotopes in chemical studies.

ARCS IN INERT ATMOSPHERES AND VACUUM. Electrochemical Society Symposium, San Francisco, Calif., May 1956. Edited by W. E. Kuhn. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1956. 188 pages, 8½ by 11 inches, bound. $7.50. Fundamentals, design and operation of furnaces, and chemical applications are the major phases of arc technology covered. Papers on furnaces deal with vacuum arc melting of refractory metals; a pilot-model, three-phase consumable-electrode arc furnace; electrode control systems; vacuum remelting of superalloys and steels; and West German developments in vacuum arc melting of titanium and zirconium. Papers on applications deal with applications if the high intensity arc in metallurgy and in process chemistry, and with energy transfer in the high intensity arc.

BRANS' EQUIVALENT RADIO TUBES VADE-MECUM. Edited by J. A. Gijsen. P. H. Brans, Ltd., Antwerp, Belgium, thirteenth edition, 1957. 342 pages, 8 by 11¾ inches, paper. Price not given. A listing of available tubes by type and serial designation, with equivalent or near-equivalant replacement types given in parallel columns. Differences, internal construction, and characteristics of the equivalent tubes are indicated. Thirty-seven types of tubes from the principal makers in Europe and the United States are represented.

CHANGES OF STATE. By H. N. V. Temperley. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1956. 324 pages, 6¼ by 10 inches, bound. $7.50. This is intended primarily for the mathematical physicist, but should be useful to all research workers interested in phase transition. It is a collation of recent advances and concepts concerning such topics as evaporation and liquefaction, freezing, solubilities, ferromagnetism, superconductivity, and phase transition in liquid helium. An important feature of the book is the application of mathematical methods to the description and prediction of physical states. A list of references accompanies each chapter.

DOCUMENTATION IN ACTION. Edited by J. H. Shera and others. Reinhold Publishing

Corporation, 430 Park Ave., New York 22, N. Y., 1956. 471 pages, 6 by 9¼ inches, bound. $10. A record of the 1956 Western Reserve Conference on the "Practical Utilization of Recorded Knowledge—Present and Future." The proceedings are presented in five main parts: (1) present requirements, methods, and problems; (2) programs for the future; (3) discussion of information processing including the use of recorded information in research, information theory, and retrieval of recorded information; (4) establishment of co-operative programs; and (5) definition of research areas (a summary). Terminology problems, machine translation, automatic processing, and other special aspects are considered.

ELEKTROTECHNIK AUF HANDELSSCHIFFEN. By H. J. Kosack and A. Wangerin. Springer-Verlag, Berlin, Germany, 1956. 482 pages, 6¼ by 9¼ inches, bound. DM 55.50. A comprehensive treatment of the generation and distribution of electricity on merchant vessels. The three sections are divided as follows: power supply, electric motors above and below deck, switchgear, lighting, electric heating; electric propulsion equipment, both a-c and d-c, and electromagnetic slip couplings; indicating and recording instruments, command and communication equipment.

HANDBUCH DER TECHNISCHEN ELEKTROCHEMIE. VOLUME IV. *Part 2A.* Die Anwendung des Elektrischen Ofens in der Industrie der Eisenmetalle. *Part 3A.* Elektroöfen in der Industrie der Nichteisenmetalle. Edited by Georg Eger. Akademische Verlagsgesellschaft, Leipzig, Germany, 1955, 1956. 464 pages, 323 pages, 6¼ by 9¼ inches, bound. DM 54, DM 36. Two new separately bound parts of an extensive and comprehensive series on industrial electrochemistry: Vol. IV, part 2A. The first half deals with the general aspects of the electric furnace in the iron and steel industry, types used, and the characteristics of refined steels. The second half covers the production of pig iron in the electric furnace with full details and a comparison with conventional blast furnace practice. Vol. IV, part 3A. Application of the electric furnace in the nonferrous industry. The six chapters describe and discuss the equipment and procedures for the electric smelting and other electrothermal treatments of tin, zinc, aluminum, magnesium, copper, nickel, cobalt, and lead.

INTRODUCTORY ELECTRICAL ENGINEERING. By G. F. Corcoran and H. R. Reed. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1957. 527 pages, 6 by 9¼ inches, bound. $7.95. A revision of Corcoran's "Basic Electrical Engineering," this text, for a first course, explains the fundamentals of electric charge and electric current, considers circuit analysis and magnetic field concepts, and treats the electric field in somewhat more detail. Ferromagnetic circuits, inductance, capacitance, and boundary-layer voltages are the other major topics treated.

AN INTRODUCTION TO ELECTROSTATIC PRECIPITATION IN THEORY AND PRACTICE. By H. E. Rose and A. J. Wood. Constable and Company, Ltd., London, England, 1956. Distributed by Essential Books, Fair Lawn, N. J., 1956. 166 pages, 5 by 8 inches, bound. $2.80. This short monograph is a critical review of the present knowledge of the subject, as carried out by experts in the field and as seen in light of the authors' own researches. Some of the subjects covered are basic electrical theory, precipitator efficiency from a theoretical and practical viewpoint, precipitator problems, and precipitator design and construction. The book is intended for the practical man concerned with gas cleaning as well as for the student.

JAHRBUCH DER ELEKTROWÄRME. Edited by Harald Müller. Vulkan-Verlag, Essen, Germany, 1956. 726 pages, 6¼ by 9¼ inches, bound. DM 64. This first of a proposed series of annual volumes summarizes current knowledge in the various fields of application of electric heating. Each of the 16 sections has one or two long articles plus brief German abstracts of pertinent reports from the third International Congress on Electric Heating, 1955. The fields covered include ferrous and nonferrous metals; wood, plastics, and other nonmetallic materials; drying and hardening processes; furnaces and auxiliary equipment; domestic and farm electric heating; power supply; special industrial uses.

LECTURES ON ROCK MAGNETISM. By P. M. S. Blackett. The Weizmann Science Press of Israel, 1956. 131 pages, 5½ by 8½ inches, bound. Available from Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. $5. Increased knowledge of the magnetism of rocks will, according to the author, have a profound effect on geophysical studies of the earth's crust. In this small book, the author gives his view of the use of magnetic data to trace the history of the earth's magnetic field; discusses his experiments to determine the cause of reverse magnetization; and reviews recent studies relevant to the movement of land masses and the history of the earth's field.

LUBRICATION OF BEARINGS. By F. T. Barwell. Butterworths Scientific Publications, London, England, 1956. 292 pages, 5½ by 8¾ inches, bound. $10. A compact presentation of data drawn from significant work published in the last 50 years. Intended to aid the practicing engineer in the design of bearings, the book covers the nature of surfaces, wear, viscosity, and other fundamentals, outlines the principles of hydrodynamic lubrication, and presents a tentative approach to design. Thrust bearings, concentrated contact bearings, externally pressurized bearings, and oscillating bearings are covered.

THE NATIONAL FIRE CODES. Volume 5. Electrical. Revised to July 1956. Published 1956 by the National Fire Protection Association (NFPA), 60 Batterymarch St., Boston 10, Mass. Various pagings, 5½ by 8¾ inches, bound. $6. This volume contains the text of the National Electrical Code which gives the basic minimum provisions considered necessary for safety for wiring design, materials, and methods; motors, generators, capacitors, and other equipment; hazardous locations, bulk storage plants, garages, etc.; cranes, elevators, induction heating, machine tools, and other special equipment, emergency systems; communication circuits; and radio and television equipment. The volume also includes standards on electrical fire alarm and supervisory services, lightning protection, and static electricity. References are made to electrical provisions of other NFPA standards.

ON HUMAN COMMUNICATION. By Colin Cherry. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1957. 333 pages, 5¾ by 9¼ inches, bound. $6.75. A group of essays introducing a new series, "Studies in Communication," which will appear during the next few years. It is not a mathematical exposition of the theory of communication, but a reasoned appraisal of the relationships existing between the diverse studies of communication. Although chiefly concerned with linguistics and information theory, much of the content and discussion can be useful to the telecommunication engineer or the researcher in machine documentation.

PROGRESS IN NUCLEAR ENERGY. Series 5. Metallurgy and Fuels. Edited by H. M. Finniston and J. P. Howe. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1956. 805 pages, 6 by 9¼ inches, bound. $21. The first volume in this series consists of individual papers grouped under nine major divisions: production and preparation of uranium, thorium, beryllium and zirconium, physical metallurgy of plutonium, preparation and properties of rare earths, ceramics, fuel elements, irradiation effects, and solid state physics. The papers deal with a wide range of metallurgical problems involved in the production of serviceable fuel elements, coolants, and moderators for reactors.

REFERENCE DATA FOR RADIO ENGINEERS. Published by the International Telephone and Telegraph Corporation, 67 Broad St., New York 4, N. Y., fourth edition, 1956. 1,121 pages 5½ by 8½ inches, bound. $6. An extensive compilation of data most frequently used by radio and electronics engineers. Prepared by specialists, it covers properties of materials, design and operation of components and major items of equipment, control systems, antennas and propagation, and such special topics as electroacoustics, digital computers, nuclear physics, and Fourier waveform analysis. Numerous charts, tables, and diagrams are scattered throughout the book, and glossaries and detailed explanations are included wherever it seemed advisable.

RELAXATION METHODS IN THEORETICAL PHYSICS, VOLUME II. By R. V. Southwell. Oxford University Press, 114 Fifth Ave., New York 4, N. Y., 1956. 522 pages, 6 by 9¼ inches, bound. $8.80. This second volume of the two-volume set discusses equations of higher order than the second, equations involving three independent variables and equations which are nonlinear. Some of the problems in the book, originally started in 1946, have been reworked, in several cases resulting in the improvement of technique. For eigenvalue problems in particular, better methods of solution have been evolved quite recently. The subject fields investigated include mechanical and electrodynamic systems, hydrodynamics, elasticity and plasticity, and membrane theory.

RELIABLE APPLICATIONS OF ELECTRON TUBES. Proceedings of the RETMA Symposium, Philadelphia, Pa., May 1956. Published 1956 by Engineering Publishers, GPO Box 1151, New York 1, N. Y. 105 pages, 8½ by 11 inches, paper. $5. The 14 papers included in these proceedings were delivered at 4 sessions devoted to field experience as an aid to design, circuits, design planning, and receiving tubes. Topics covered include trial techniques, responsibility for defective tubes, mathematical tools, proper application of tubes, etc. Papers on circuits deal with the keyed phase sensitive demodulator, design of a flip-flop, series string applications of tubes, and the application of low-mu triodes to series regulators. Specifications are discussed in a panel session.

SCIENTIFIC USES OF EARTH SATELLITES. Edited by J. A. Van Allen. University of Michigan Press, Ann Arbor, Mich., 1956. 816 pages, 6¾ by 10¼ inches, bound. $10. This compilation of 53 papers represents current thought on the utilization of artificial earth satellites for scientific purposes. Among the subjects covered are the optical and visual tracking of a satellite, satellite instrumentation, meteorological observations from a satellite, cosmic ray observations, measurements of the earth's magnetic field, plotting out of the auroral zone, studies of ionospheric structure, and detection of meteoric particles. All the papers were presented at the 10th Anniversary meeting of the Upper Atmosphere Research Panel, in January 1956.

SOLID-STATE PHYSICS, VOLUME 3. Edited by Frederick Seitz and David Turnbull. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1956. 588 pages, 6 by 9¼ inches, bound. $12. The present volume consists of six surveys covering the following areas of the field: Group III–Group V compounds, the continuum theory of lattice defects, order–disorder phenomena in metals, phase changes, ferromagnetic domain theory, and relations between concentrations of imperfections in crystalline solids. Extensive references are included as bibliographical footnotes or are listed at the end of a given paper.

TECHNICAL ASPECTS OF SOUND. Volume II. Ultrasonic Range, Underwater Acoustics. By E. G. Richardson. Elsevier Publishing Company, 1957. Available in the United States from D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 412 pages, 6 by 9¼ inches, bound. $11. A comprehensive treatment by experts of the several branches of acoustic science, of which the previous volume dealt with the sonic range and mainly with airborne sound. The present volume, in three divisions, covers ultrasonic transducers and applications, underwater acoustics, and aircraft noise, with a special chapter on underwater propulsion noise. Before each division there is a discussion of the fundamentals of the subject, and there is an extensive bibliography for each section of the division. The emphasis on applications points up its practical value as well as its use as a text.

TELEVISION ENGINEERING HANDBOOK. Edited by D. G. Fink. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1957. Various pagings, 6 by 9¼ inches, bound. $18. This handbook of 1,600 pages and 1,150 illustrations is a detailed and comprehensive compilation by 33 experts in 20 special fields. Monochrome and color receivers are given equal coverage, and other subjects included are television standards, cathode-ray devices, synchronization of scanning and color coding, composite video signals, waveforms and spectra, television receivers, circuit design and component specifica-

tions, and television transmitters and auxiliary equipment. There are tables of television standards in various countries as well as the five systems in use, and detailed circuit diagrams of typical monochrome and color receivers. References cited in the text are at the end of each chapter.

THEORY OF LAND LOCOMOTION. (The Mechanics of Vehicle Mobility) By M. G. Bekker. The University of Michigan Press, Ann Arbor, Mich., 1956. 520 pages, 6 by 9¼ inches, bound. $12.50. A comprehensive compilation of the information now available on the relationships between an operating motor vehicle and its physical medium, particularly in off-the-road locomotion. The subjects covered include locomotion in nature and on wheels, problems of soil and snow mechanics, track-laying vehicles, ski and toboggan equipment, motor vehicle mechanics, trafficability of soils, and dimensional analysis. A bibliography of some 350 references is included.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

SINGLE-SIDEBANDS IN COMMUNICATION SYSTEMS. A BIBLIOGRAPHY. A bibliography of material published between 1921 and July 1956 on the single-sideband method of transmission in communication systems has been compiled by the U. S. Navy and released for industry use through the Office of Technical Services (OTS), U. S. Department of Commerce. Since it was conceived in 1915, considerable research and development has been devoted to single-sideband, suppressed carrier transmission, particularly as a means of obtaining economy of spectrum, savings in power, and reduction of selective fading. The bibliography contains 492 references to unclassified books, articles, and research reports on the method. Some articles on high-frequency crystal units and crystal lattice filters also are noted, since development in single-sideband tuning has depended on advances in quartz crystal manufacturing. The volume, *PB 111837*, M. Benton, Naval Research Laboratory, September 1956, may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C. It contains 105 pages, price $2.75.

ARCS IN INERT ATMOSPHERES AND VACUUM. Edited by W. E. Kuhn, published by John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. The book, latest in the series sponsored by The Electrochemical Society, Inc., is based on papers presented at the symposium on this subject, planned by the Electrothermics and Metallurgy Division of the Society, and held at its Spring 1956 meeting in San Francisco, Calif. The book is the first of its kind to treat the subject of arcs in inert atmospheres and vacuum, and their applications to the melting of metals by the "cold crucible" process. It also treats the chemical and metallurgical applications of that other new field of arc technology—the "high intensity" arc. The diversified selection of materials and viewpoints contained here includes developments in the United States and West Germany, the work of competing companies, and the ideas of several specialists actively engaged in arc research. The papers appear under four leading sections: the past and present status of high current arc technology, arc melting fundamentals, design and operation of arc melting furnaces, and chemical applications of arcs. 188 pages, $7.50.

CONVEYOR TERMS AND DEFINITIONS. The guide to standards for conveyors as approved by the American Standards Association is now "Conveyor Terms and Definitions," the industry dictionary published by the Conveyor Equipment Manufacturers Association (CEMA). It is identified as American Standard *B 75.1-1956, UDC No. 621.-867:001.4*. CEMA's popular 64-page dictionary was first published in 1952, and about 25,000 copies are in use by conveyor manufacturers and users and others throughout the world, according to R. C. Sollenberger, CEMA executive vice-president. It defines nearly 1,500 terms applied to conveyors and conveyor equipment and contains nearly 100 line drawings. Copies have been placed in American Standards Association libraries throughout the world and conveyor manufacturers are providing copies to state safety officials to help overcome confusion as to safety provisions that must be applied to conveyors. Copies are available from CEMA, One Thomas Circle, Washington 5, D. C., at $1 each.

PROCEEDINGS OF THE TIME AND MOTION STUDY AND MANAGEMENT CLINIC. Now available are the Proceedings of the 20th Anniversary Time and Motion Study and Management Clinic sponsored by the Industrial Management Society, October 31, November 1-2, 1956, at the Hotel Sherman, Chicago, Ill. 112 pages including charts, forms, and illustrations. Complete transcripts of talks by top leaders of labor, management, and Government on various topics including time study, motion economy, methods, work simplification, plant layout, production control, wage incentives, maintenance, and job evaluation. Published by the Industrial Management Society, 35 E. Wacker Drive, Chicago 1, Ill. Price—$5.

PRACTICAL ELECTRICAL WIRING: RESIDENTIAL, FARM, AND INDUSTRIAL. Fifth Edition, based on the 1956 National Electrical Code. By H. P. Richter. 602 pages. Illustrated. McGraw-Hill Book Company, Inc., 330 W. 42 St., New York, N. Y. $6.75. This well-known wiring manual now has been revised to bring it in strict accordance with the latest National Electrical Code. The book explains practical methods of electrical wiring, in plain language for the man who does the work. It tells how to do all kinds of light and power wiring jobs (under 600 volts) on the farm, and in homes, factories, stores, schools, and similar structures, and presents the basic principles behind them in clear, down-to-earth terms. Special attention is given to farm wiring and to emergency standby generating plants. The treatment is planned to be simple enough for beginners, yet complete enough to be valuable to those already doing electrical work. Only ordinary arithmetic is required to understand the book. H. P. Richter, is director of procurement and manager of cost department, D. W. Onan & Sons, Inc., manufacturers of engine-driven generating plants, and a member of the International Association of Electrical Inspectors and of the American Association of Agricultural Engineers. Further details are available from McGraw-Hill's Book Information Service, 327 W. 41st St., New York 36, N. Y.

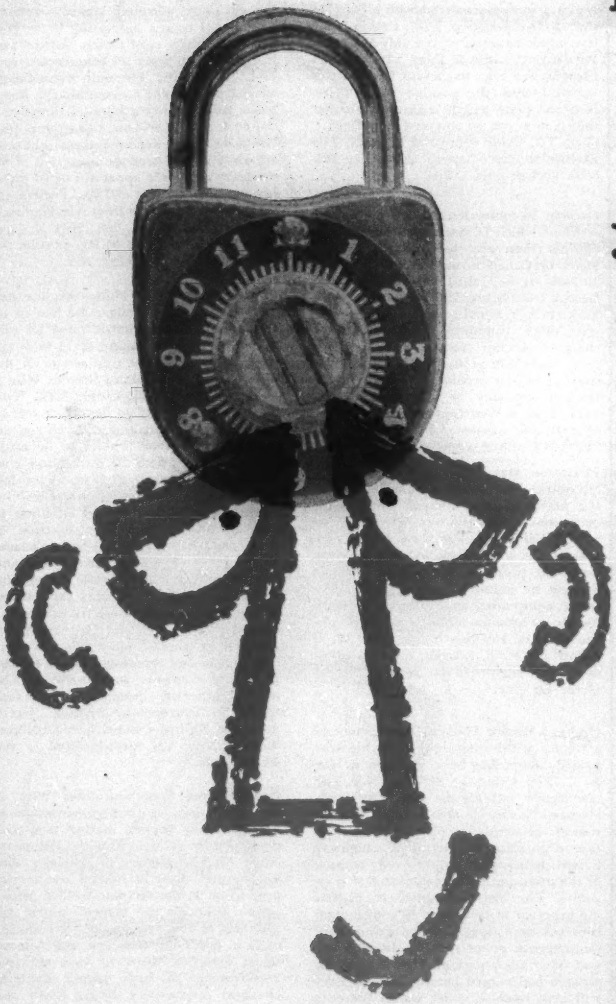
ESSENTIALS OF MACHINERY PROCUREMENT AND DEVELOPMENT. Published by the American Management Association (AMA), 1515 Broadway, Times Square, New York 36, N. Y. Special Report *No. 14*, 71 pages, price $2.50 (AMA members: $1.75). To offset rising costs and reduce the amount of equipment made obsolete by technological change, management must plan intelligently for machinery equipment. It must understand the complex problem involved in purchasing and developing new equipment. This AMA report supplies practical, specific solutions to many of the questions posed by this problem. It includes a detailed presentation by Merck-Sharp & Dohme of its successful program for the acquisition of capital equipment. Company executives discuss the role of each department (production, finance, engineering etc.) in carrying out the over-all plan. Other papers consider such important factors in machinery procurement as financial and tax considerations (American Pulley Company), techniques for safeguarding the buyer of equipment (American Cyanamid Company), procurement in a multiplant company (The Norton Company), and spending a limited equipment budget (Mueller Brass Company).

THE WESTERN ELECTRIC ENGINEER. The first issue of a new technical magazine, *The Western Electric Engineer*, was published in January by the Western Electric Company. Appearing quarterly, the magazine will contain comprehensive articles on many branches of engineering at Western Electric, the manufacturing and supply unit of the Bell Telephone System. It will go to Western Electric's engineers, and also will be available to technical and scientific people outside the company. The first issue contained 10 feature articles, including a number on recent technical developments. New processes are reported for cutting quartz crystals used in communications work, resulting in economies in material. There is an article on a recently developed transistorized time-division multiplex—one fifth the size and weight of former devices for transmitting a number of telegraph messages simultaneously over a single set of wires. Another article described special manufacturing methods required for extremely precise mass production of intricately twisted waveguides, used in radar and microwave radio. Among the new magazine's departments is "The Engineer and Society," which contains short articles reflecting the increasing social responsibility of the engineer. To help him anticipate and shape the future, one article reports, educators are advocating more study by the engineer in the humanities and social sciences. Engineers, physicists, chemists, mathematicians, and other technical people will contribute articles to *The Western Electric Engineer*, according to an editor's foreword. M. J. O'Leary, formerly editor of the *Bell Laboratories Reporter*, is editor of the magazine.

ECONOMIC GROWTH PROJECTOR TO 1970. This new edition of a long-range business planning guide for executives shows the projected increase each year, 1957 to 1970, of 10 key economic growth factors. Included are population, gross national product, industrial stocks, factory output, hourly wage rates, and wholesale prices. The new projector also shows the mathematically computed long-term percentage growth rate of each key factor, with the results computed out to each of the next 15 years. Pocket size, single copies $1, postpaid, from the publishers, The Eddy-Rucker-Nickels Company, 4 Brattle St., Cambridge, Mass.

ELECTRICAL SYSTEMS DESIGN. By J. F. McPartland and the editors of *Electrical Construction and Maintenance*. 135 pages, illustrated. McGraw-Hill Book Company, Inc., 330 W. 42 St., New York, N. Y. $6. This practical book sets forth standards of good electrical systems design as found in actual current practice. It gives complete coverage of the design of modern and efficient electrical systems for power, light, heat, and communication. Installations in commercial, industrial, institutional, and residential buildings are considered. Step-by-step procedures are shown for selecting designs that will fulfill electrical power requirements; for implementing these designs with actual equipment and hardware; and for incorporating the resulting system within the physical dimensions of a building. Electrical contractors, architects, electrical estimators, all in this field will find a complete over-all picture: basic wiring concepts and configurations; circuit and distribution designs; types, sizes, models, characteristics, of actual conductors, apparatus, and hardware; and complete installation procedures. Comprehensive, profusely illustrated, it will provide self-training in systems design for the newcomer to this field, reference data for practicing designers, and a view of modern trends in electrical design and construction for all. The book is an outgrowth of material developed for *Electrical Construction and Maintenance*. For further information write to McGraw-Hill's Book Information Service, 327 West 41st St., New York 36, N. Y.

BISMANOL PERMANENT MAGNETS, EVALUATION AND PROCESSING. E. Adams and W. M. Hubbard, Naval Ordnance Laboratory. January 1953. 19 pages. 50¢. Order *PB 121278* from Office of Technical Services (OTS), U. S. Department of Commerce, Washington 25, D. C. Bismanol permanent magnets possess remarkable flux constancy over a wide temperature range after stabilization at low temperatures, according to this report of evaluation of their stability under various operating conditions. In addition, the magnets are extremely stable magnetically to shock, vibration, centrifugal force, and stray magnetic fields. Except for a tendency to chip, the bismanol devices showed sufficient strength for most applications. With a protective coating, the magnets maintained corrosion stability at room temperatures and moderate humidities for the six-month test period. Improved fabrication techniques and equipment are also described in the report. Methods of determining percentage purity, alignment, and effective particle size in the magnets are discussed. The report recommends bismanol magnets up to two inches in diameter for applications requiring high magnetic flux density, such as in loudspeakers.



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Motive Power Battery. This scientific development has made possible new capacity standards for storage batteries used to power electric industrial trucks. Engineered by Exide Industrial Division of The Electric Storage Battery Company, it has enabled the manufacturer to pack significantly more storage battery power into a given space, an increase of 44% in the rated capacity of Exide-Ironclad motive power batteries within only 3½ years. Polyvinyl chloride is lined with braided fiberglas as a filler to prevent fall of active material from the positive plate; therefore, the plate length is greater. Further information can be obtained from Department TG, Exide Industrial Division, The Electric Storage Battery Company, Box 8109, Philadelphia 1, Pa.

German Selenium Rectifiers. This line of rectifiers which is much smaller yet more efficient than any now on the United States or Canadian market will be made and sold in the United States by the Radio Receptor Company, 251 W. 19th St., New York 11, N. Y. Smaller radio and television sets, office computers, storage battery chargers, elevator controls, telephone circuits, and other products will result from the use of the rectifiers. They were developed originally by Siemens Schuckertwerk, A. G., a West German manufacturer of electronic components and equipment.

Electronic Manufacturing Company. An electronic manufacturing firm named the Kelvin Electric Company, has begun operations in recently completed facilities at 5907 Noble Ave., Van Nuys, Calif. Products of the newly organized company are improved precision wire-wound resistors for use in industrial and military electronic equipment, and resistive networks for use as attenuators and precision voltage dividers. Heading the firm are W. I. Elliott and K. T. Eckardt, formerly president and vice-president, respectively, of Hycor Co., Inc.

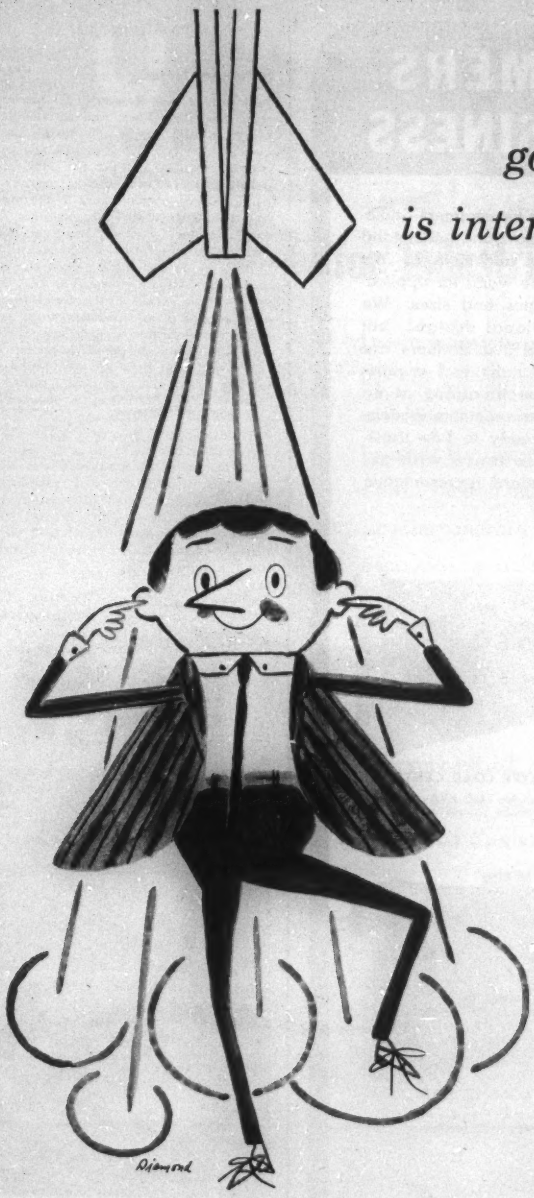
Highway Hazard Flasher. Development of a wholly transistorized electronic highway hazard flasher has been disclosed by the R. E. Dietz Company, Syracuse, N.Y. The new flasher, possibly the world's first such electronic device, is now in mass production at the company's plant. The application of an electronic circuit to a highway hazard light is practical now only because of the invention and development of transistors. The electronic highway flashers are expected to be a boon to construction concerns, municipal highway maintenance departments, police and fire departments, and other organizations with a need for reliable and rugged hazard flashers. They will even operate under water. Batteries used in the flasher have a life expectancy of over 1,200 working hours.

Mobile Laboratory. A mobile r-f measurement laboratory, completely shielded to make on-the-spot r-f interference studies has recently been designed in co-operation with the Filtron Co., Inc., manufacturers of a complete line of r-f filters for industrial and military applications. Basically, the body of the mobile laboratory is a standard Ace shielded enclosure mounted on a flat-bed Chevrolet truck. Standard Ace RFI design (Lindsay structure) gives the enclosure adequate rigidity through sturdy steel frames supporting heavy gage galvanized sheet steel panels. Attenuation is over 100 db from all frequencies from 14 kc to 1,000 mc. The unit is completely weatherproofed and air conditioned. Regulation truck lights are mounted directly on the enclosure. Two power generators provide adequate power for internal lighting, air conditioning, and the operation of all necessary electronic apparatus at 60 cycles per second (cps) and 400 cps. Further information is available from Ace Engineering and Machine Co., Inc., 3644 N. Lawrence St., Philadelphia 40, Pa., or from the Filtron Co., Inc., Flushing, N.Y.

Impulse Generator. A Philips impulse generator of advanced design, the first of its kind in the United States, rated 1.4 million volts with an energy of 16 kilowatt-seconds, has been put into service in the high voltage laboratory of Simplex Wire & Cable Company, Cambridge, Mass. This installation will play an important role in the company's expanding research and development program. Studies to be made will cover variations in mechanical construction of cable as well as insulation factors on materials of varying thickness. Investigations will give special attention to breakdown properties as a function of time and all work will be correlated closely with lightning, switching, and power surge problems. Small dimensions, low selfinductance, low stray capacitance, and high stored energy are features of the new impulse generator. Full energy is available at one-half and one-fourth nominal voltage and the design allows for the possibility of impulse current testing. The impulse generator installation, purchased from the Instruments Division, North American Philips Company, Inc., Mount Vernon, N.Y., was manufactured in the Netherlands.

Copper-Plated Communications Wire. A communications wire of high-strength steel with a heavy copper coating has been developed by National-Standard Company, Niles, Mich., producer of specialty wire for industry. It is in limited commercial production at the company's Niles, Mich., plant. Although the biggest volume application of the new product is expected to be in telephone, telegraph, and railroad signal lines, the wire will meet multiple requirements of high tensile strength, electrical conductivity, bright finish and resistance to fatigue, and corrosion. The copper coating is joined to the steel core in a permanent bond that permits twisting, stranding, weaving, braiding, bending, or flattening the wire without rupturing the bond.

(Continued on page 24A)



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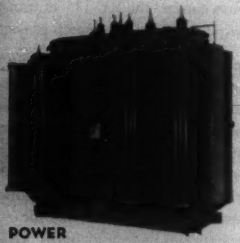
TRANSFORMERS ARE OUR BUSINESS

DISTRIBUTION

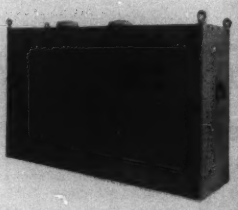
OISC distribution transformer, 75 KVA, 2400/4160Y to 120/240 volts, single phase, 60 cycle.

Standard builds transformers—nothing else. We know and understand them backward and forward. We ship all over the world for applications of all types and sizes. We build conventional designs, but many Standard Transformers are custom-built to individual requirements and specifications at no greater cost than repetitive models. When you're ready to buy transformers, get in touch with us. There's a Standard representative nearby.



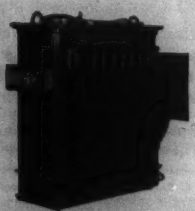
POWER

Standard builds in sizes to 10,000 KVA and incorporates any special features required.



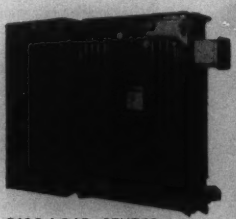
DRY TYPE LOAD CENTER

Sizes up to 1,000 KVA and maximum voltage ratings of 4,800.



NETWORK TYPE

In all commercial and NEMA ratings.



OISC LOAD CENTER

Designed and equipped with the switchgear you prefer.

Standard®

WARREN, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

(Continued from page 18A)

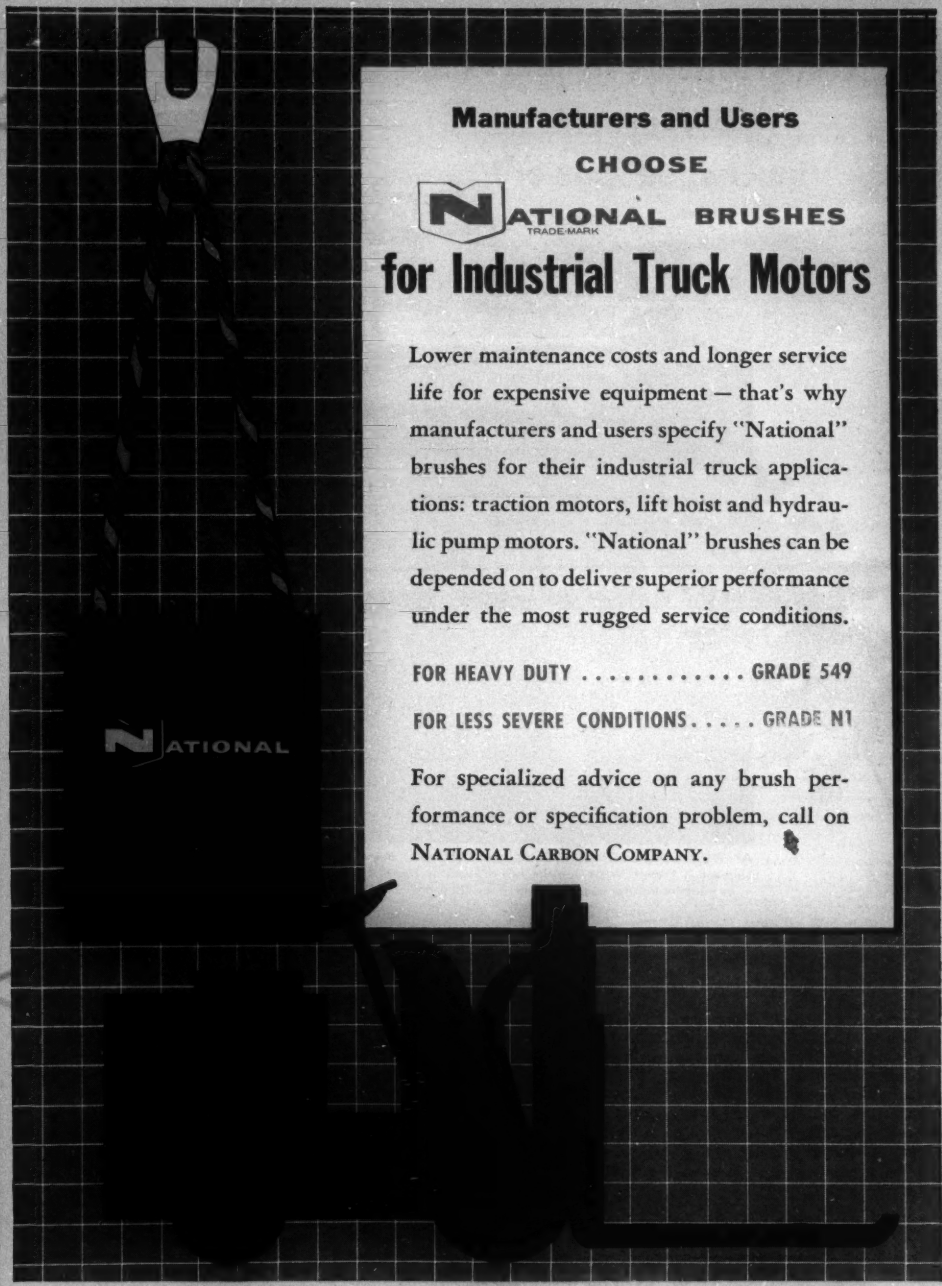
Industrial Notes

Beckman *112* for Research. To speed research on the "Thor," an intermediate-range ballistic missile now being developed for the U.S. Air Force, Douglas Aircraft has placed an order for a 200-channel Beckman *112* completely transistorized data-processing system made by the Scientific Instruments Division, Beckman Instruments, Inc. Douglas will use the Beckman *112* to monitor up to 200 individual thermocouples and strain gauges attached to missile parts under test. The Beckman system automatically orders this information, adjusts it to standard values, converts the electronic signals into digital form, and prints the result on an electric typewriter. The data are also automatically punched into paper tape, which is taken to a computation center for further processing by a digital computer. Using this information, Douglas engineers will adjust their designs to meet the rigorous conditions of flight at thousands of miles per hour through the near vacuum of outer space. For further information contact: E. L. Van Deusen, Press Bureau, Data and Control Systems Department, Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif.

Multimedia Dynograph Recorder. This 8-channel, high-speed, direct-writing oscillograph offers, for the first time in one unit, the choice of three different media for recording. The Dynograph unit permits the use of ink or electric sensitive paper for curvilinear recording (*top*), or heat sensitive paper for rectilinear recording (*bottom*). Manufactured by Offner

Electronics, Inc., 5320 N. Kedzie Ave., Chicago 25, Ill., the Dynograph makes possible the rapid substitution of one recording medium for another. The unit is equipped with inkwells and with stylus

(Continued on page 26A)



Manufacturers and Users

CHOOSE

NATIONAL BRUSHES

TRADE-MARK

for Industrial Truck Motors

Lower maintenance costs and longer service life for expensive equipment — that's why manufacturers and users specify "National" brushes for their industrial truck applications: traction motors, lift hoist and hydraulic pump motors. "National" brushes can be depended on to deliver superior performance under the most rugged service conditions.

FOR HEAVY DUTY . . . . . GRADE 549

FOR LESS SEVERE CONDITIONS . . . . . GRADE N1

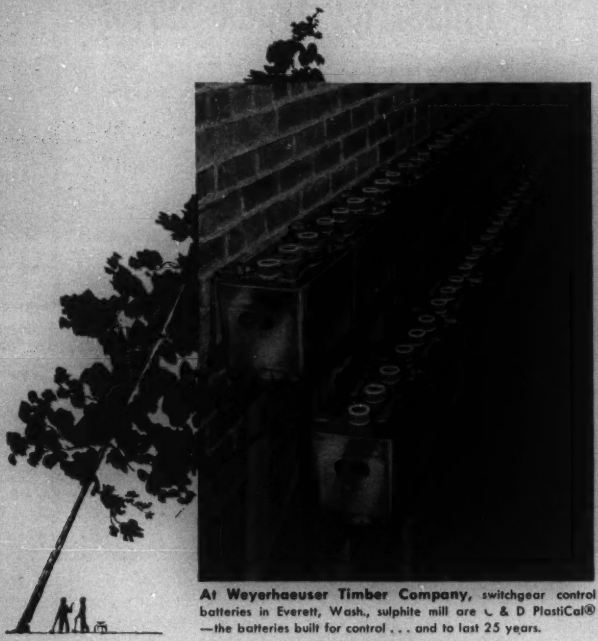
For specialized advice on any brush performance or specification problem, call on NATIONAL CARBON COMPANY.

The term "National", and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY • A Division of Union Carbide and Carbon Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto

control batteries are built for
25 years of
"packaged power"



At Weyerhaeuser Timber Company, switchgear control batteries in Everett, Wash., sulphite mill are C & D PlastiCal® —the batteries built for control . . . and to last 25 years.

. . . they're C&D PLASTICAL®

Not just "batteries"! These are *engineered* C & D PlastiCal® (lead-calcium) control batteries—batteries specifically designed for switchgear, control, and auxiliary power service —batteries built to deliver high, steady output with only minimum maintenance *for the next quarter-century!*

Weyerhaeuser Timber Co., big suppliers of woodpulp to the paper and allied industries, wanted more than just batteries. Their choice: C & D PlastiCal®—the control batteries with the "more battery for the money advantages."

See why

For details, send for Bulletin CP-536. Find out about the battery of tomorrow—today!

C&D BATTERIES, INC.
of Conshohocken, Pa.
Since 1906
Sales and service offices in principal cities from coast to coast

(Continued from page 24A)

Industrial Notes

heating facilities. Styli are interchanged when shifting from one medium to another and can be lifted from their cradles without the use of tools. The only part of the paper drive mechanism which must be interchanged is the pressure roll against the paper feed roll. For electric sensitive recording the assembly is used much the same as with the ink recording; the styli, however, have stainless steel wires which are connected to a voltage source to mark the paper. It employs a chopper amplifier which can be used for all applications. It is free of drift, yet has a sensitivity of 15 microvolts per mm of pen deflection. This permits strain gauges to be excited with d-c and avoids the complexity of carrier systems and their necessary reactance balance. The same amplifier can be used equally well with thermocouples for temperature recording, for all types of a-c and d-c recording, and with reluctance gauges. In the latter application, the chopper converts a-c to d-c before application to the gauge. Detailed literature is available on request.

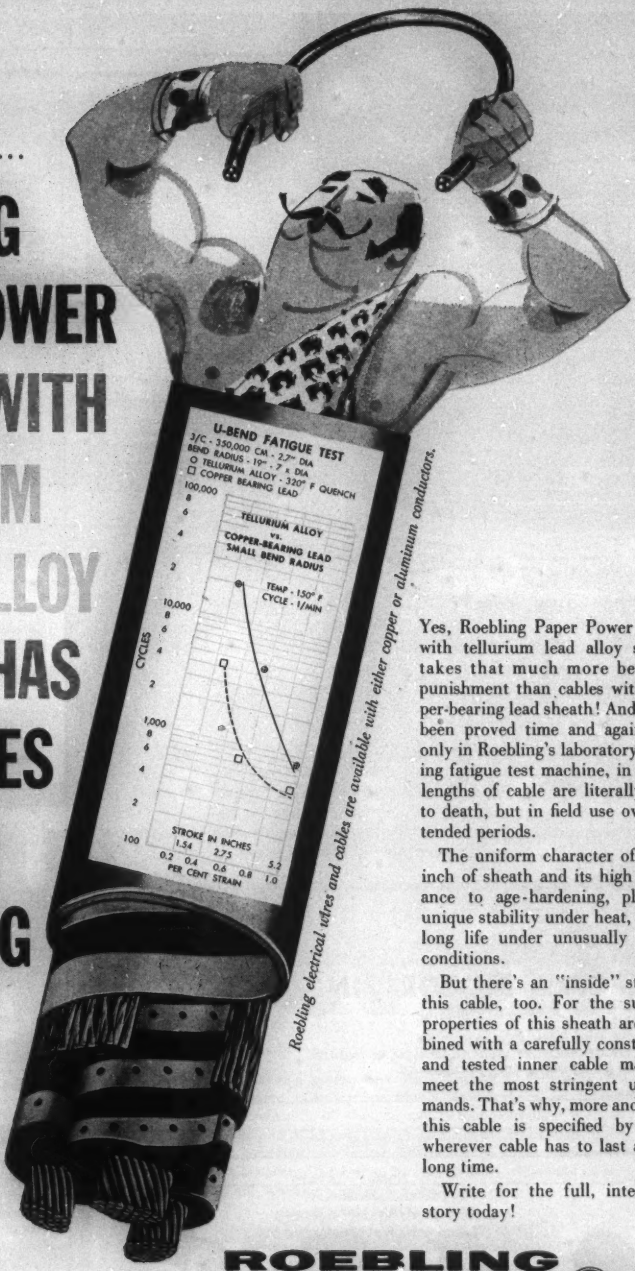
Temco. A process which saves an estimated $5,000 a month in fabrication of the expensive wonder metal, titanium, has been developed by Temco Aircraft Corporation, Dallas, Tex. Most of the saving comes from fewer parts being rejected due to unevenly etched surfaces. The company has received a patent on the new process, called "Ti-Brite." Developed in Temco's materials and processing laboratories by J. J. Dailey, "Ti-Brite" removes a tough oxide scale from titanium through electrolysis. Rejection of parts proved costly. Standard methods being used to remove scale involved considerable hand labor and expensive installations. In many cases, acid baths removed the scale, but etched the metal underneath unevenly. Where no scale was present, such as on edges of newly punched rivet holes, such etching made the parts unusable by elongating the holes. One man now handles an operation that formerly required eight and involved much hand-scrubbing of parts between immersions of the material in acid pickle.

Electromagnetic Switch. The Powerloid is a power-type switch actuated by a solenoid plunger. It combines the characteristics of both a relay and a solenoid. Designed primarily for heavy-duty motor and heater loads, the unit has been tested for 230 volt a-c, motor loads up to 3 hp., and for heater units up to 8,400 watts. The unit is built for rugged usage and is totally enclosed. Applications include washing machines, high-speed dryers, air conditioning and refrigeration equipment, built-in and electronic ovens, magneto starters, and battery chargers and heater controls. For further information write the manufacturer, Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

(Continued on page 28A)

No bending problem here, because...

ROEBLING PAPER POWER CABLE WITH TELLURIUM LEAD ALLOY SHEATH HAS 4½ TIMES GREATER BENDING LIFE!



Roebling electrical wires and cables are available with either copper or aluminum conductors.

Yes, Roebling Paper Power Cable with tellurium lead alloy sheath takes that much more bending punishment than cables with copper-bearing lead sheath! And that's been proved time and again, not only in Roebling's laboratory bending fatigue test machine, in which lengths of cable are literally bent to death, but in field use over extended periods.

The uniform character of every inch of sheath and its high resistance to age-hardening, plus its unique stability under heat, assure long life under unusually severe conditions.

But there's an "inside" story to this cable, too. For the superior properties of this sheath are combined with a carefully constructed and tested inner cable made to meet the most stringent use demands. That's why, more and more, this cable is specified by name wherever cable has to last a long, long time.

Write for the full, interesting story today!

ROEBLING

JOHN A. ROEBLING'S SONS CORPORATION

Trenton 2, N. J. • Branch Offices in Principal Cities

Subsidiary of The Colorado Fuel and Iron Corporation

FIRST IN ALUMINUM
FOREMOST IN QUALITY

ELECTRA-GEARMOTOR *housings are cast of heat treated alloy of aluminum, distinctive because of:*

- More resistance to corrosion
- Higher tensile strength
- Better shock resistance
- Faster heat transfer
- Superior finish
- Lighter weight

Excellence in modern design is yours when you choose ELECTRA-GEARMOTORS *with these quality features:*

- Exclusive GLAMICONE insulation
- Superior high density rotors
- Extra splash-proof protection
- Precision heavy-duty gearing
- Double protection against oil leakage
- Micro-finish on shafts for oil seals
- High speed ball bearings
- Low speed tapered roller bearings
- Special "tang" shaft-rotor to worm shaft

These and many more refinements combine in motor and gear-ducer to bring you a product which is truly foremost in quality.

ELECTRA MOTORS, INC.

Anaheim, California

Please send latest information on ELECTRA-GEARMOTORS, *right angle type, as featured above for ratings from ¼ hp to 5 hp.*

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

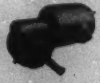
P.S. I am also interested in OTHER ELECTRA PRODUCTS

EE-1

ELECTRA-GEARMOTORS
Parallel Shaft
½ to 30 hp

ELECTRA-GEABEDUCERS
Right Angle
¼ to 5 hp

ELECTRA-MOTORS
½ to 75 hp



ELECTRA-GEARMOTORS
Shaft Mounted
¼ to 5 hp

(Continued from page 26A)

NEW PRODUCTS

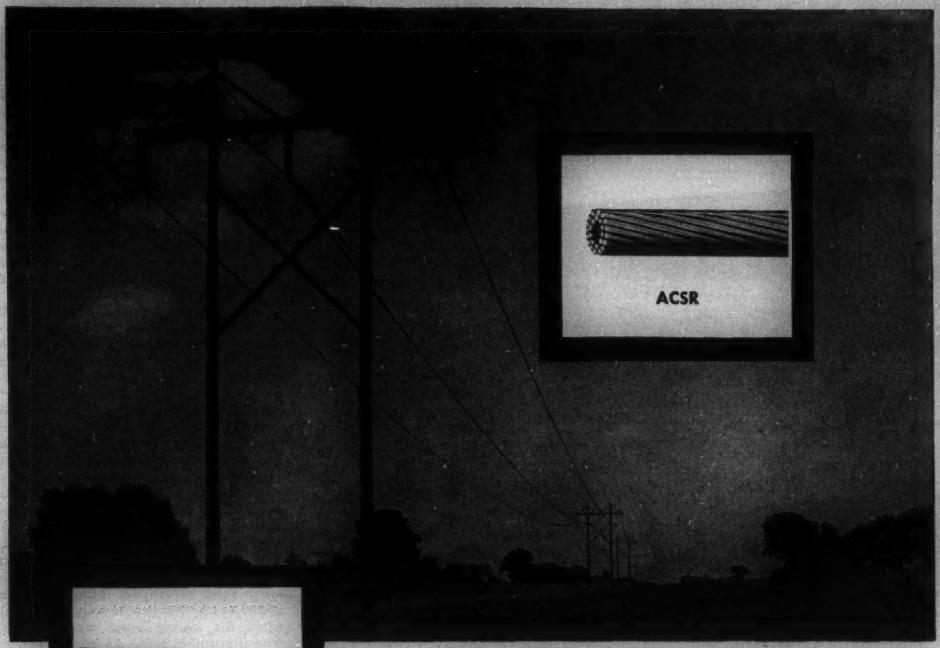
Pressure Sensitive Felt. A new adhesive tape has been announced by the Spring Packing Corporation. It is a high grade felt tape which has been carefully treated to give it additional strength. One side is coated with an extra powerful pressure sensitive adhesive applied in track form (see illustration). This results in the tape, Spring-Felt No. *124XN-T*, having far greater strength than other felt or similar tape. This low-cost tape has unlimited uses in the heating, air-conditioning, electrical, transportation, electronic, construction, and other related fields. Spring-Felt

No. *124XN-T* can be applied with finger pressure. The tape seals against dust, dirt, wind, fumes, and moisture. It eliminates squeaks and rattles and has great cushioning power. For more information about Spring-Felt No. *124XN-T*, write to Department PR, Spring Packing Corporation, 332 South Michigan Ave., Chicago 4, Ill.

Timer. A highly accurate, attractive, and compact package is being marketed by the Hagen Manufacturing Company, Moline, Ill., which eliminates the waste of power on electric furnaces, heaters, dehumidifiers, evaporators, driers, material pressers, filters, pumps, etc. It is to be used as an alternate for rheostats and other variable voltage equipment. Loads up to 25 amperes at 150 volts, 60 cycles may be handled with this timer without auxiliary equipment.

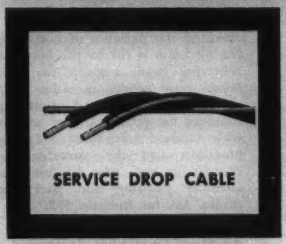
Interference Blanker. Development of a model radio interference blanker which substantially reduces, or eliminates, the crippling effects of precipitation static on airborne communications and navigation receivers has been announced by The Hoover Electronics Company, 3640 Woodland Ave., Baltimore 15, Md. Identified as the Model *10018*, the unit is the result of two years of research and development in the field of noise-blanking techniques.

(Continued on page 32A)



GENERAL CABLE

ALECTRAL ALUMINUM CONDUCTORS



Consistent, outstanding performance mark General Cable's ALECTRAL Bare and Insulated aluminum conductors. Manufactured to General Cable's high standards in all sizes. Bare ACSR and aluminum • Weatherproof aluminum and ACSR conductors • All types of service drop cables. ALECTRAL is available with a complete range of paper, rubber and thermoplastic insulations, backed up by over 75 years of General Cable's engineering and manufacturing experience.

GENERAL CABLE CORPORATION
420 Lexington Avenue, New York 17, N. Y.
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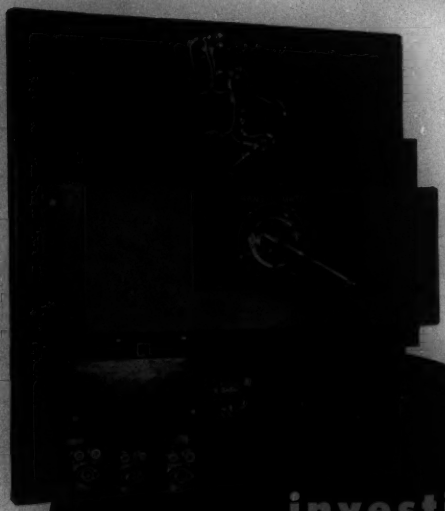
for quality and service . . . specify **GENERAL CABLE**

if YOU'RE responsible for POWER CONTINUITY



TOTAL FAILURE PROTECTION

PARTIAL VOLTAGE FAILURE PROTECTION

POSITIVE NORMAL OR EMERGENCY POSITIONS ONLY

investigate

AUTOMATIC TRANSFER SWITCHES

Trans-O-Matic's compact, failure-proof design employs two standard circuit breakers, one from the normal and one from the emergency source, either of which will supply the load. Relay-actuated motor operates circuit breakers for positive mechanical transfer with continuous service in normal or emergency position. Available in capacities to 600 volts, 800 amps, interrupting capacities to 50,000 amps RMS. Prompt delivery in most sizes.

OPTIONAL FEATURES

Adjustable time delay on restoration to 20 minutes • Engine starting contact • Test pushbutton • Pilot lights for switch position • Special enclosures

LAKE SHORE Electric CORPORATION
BEDFORD, OHIO

(Continued from page 28A)

New Products

Hearing Aid. Development of an extra-power hearing aid to bring the softest sounds to persons with extreme hearing loss has been announced by Beltone Hearing Aid Company, 2900 W. 36th St., Chicago, Ill. The five-transistor instrument, the Fortissimo, combines maximum power, high fidelity, and a 30 per-cent reduction in size from earlier extra-power aids. Such sounds as quiet music or soft speech, forgotten or never before heard by the severely handicapped, can be heard with the Fortissimo. Another feature is reduced current drain resulting in greatly increased battery life. A shielded microphone reduces external interference. The Fortissimo can be custom fitted to many different hearing losses.

Dual Beam Electric Eye. Novel applications of miniaturized electric eye controls for eliminating timers and mechanical contacts in monitoring objects moving at random positions and varying speeds have been introduced by Ess Instrument Co., Bergenfield, N.J. These applications involve dual light beams: one to time the inspection and another to monitor it. The beams may be direct light cut off or reflected, or a combination of both. In some cases, additional beams may be added to monitor two or more parameters when the timing beam says "inspect." The illustration shows an application for

checking the presence of bottle cap. The timing beam is cut by the bottle and the reflecting beam inspects for cap. Both beams must concur in order to pass assembly. Light units and photo units are standard Ess products; they may be used with standard units to effect various combinations and the assembly is small enough to get into difficult places in assembly printing and packaging machines. Ask for Bulletin 572.

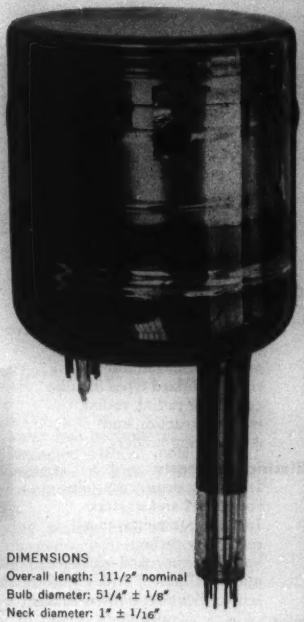
Atomizing Humidifier. Engineered and designed by Arklon Manufacturing Company, P. O. Box 3501, Cleveland 18, Ohio,

(Continued on page 34A)

NOW! CONTROLLABLE PERSISTENCE FOR TV AND RADAR

TONOTRON

Direct-display, cathode-ray storage tube by Hughes with magnetic deflection and electrostatic focusing



DIMENSIONS
Over-all length: 11 1/2" nominal
Bulb diameter: 5 1/4" ± 1/8"
Neck diameter: 1" ± 1/16"

FOR NARROW BAND, SLOW SCAN CLOSED CIRCUIT TV

Controllable long persistence makes the Tonotron ideally suited for picture transmission over conventional radio channels or telephone lines. Coaxial cables or microwave transmitters and receivers are unnecessary. Pictures up to 80 lines per inch resolution cover the full half-tone scale with controllable persistence—instantaneous or gradual erasure. Light output of 1000 foot-lamberts at 10 kv assures extremely high brightness at the viewing screen for use in high ambient-light levels.

FOR RADAR PPI DISPLAY

Because of the Tonotron's compact size, it can be used in many existing radar indicator housings. Brightness of 1000 foot-lamberts at 10 kv makes a viewing hood unnecessary, even in full daylight. Persistence can be adjusted to retain nearly maximum brightness throughout the major portion of a 360° sweep. Ability to cover the complete grey spectrum provides maximum contrast for easy identification of cloud formations, mountains, harbors and waterways, airports, ground clutter and targets.

ELECTRON TUBES

For additional information, write to HUGHES PRODUCTS • ELECTRON TUBES
International Airport Station, Los Angeles 45, California

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HUGHES PRODUCTS

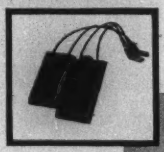
Improved
ELECTRICAL
and
MECHANICAL
PROPERTIES
— make the difference!

morganite

means...

BETTER PERFORMANCE
LOWER MAINTENANCE

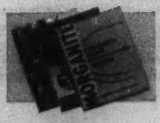
Motor and Generator Brushes
Morganite brushes enjoy a reputation world-wide for trouble-free service. Available for fractional horsepower, aircraft, automotive, traction and industrial applications.



Carbon Brush Holders
Assure high efficiency brush operation by maintaining positive contact between the brush and the commutator or ring. Standard types include cantilever radial, radial, trailing, reaction and AC slip ring holders.

Electrical Contacts
Including drum controllers, contactors and starters. Incorporate metals in a refractory carbon base for improved electrical conductivity and mechanical strength. Contacts are self-lubricating, non-welding.

Carbon Current Collectors
Reduce operating costs on travelling cranes. Cost less, wear longer and reduce conductor wear to a minimum. Will not blister or rough conductor, afford trouble-free service over extremely long periods.



Complete Catalogs Available — call or write today. Recommendations on specific applications supplied promptly on request.

Morganite
INCORPORATED . . . FOR OVER HALF A CENTURY
3308 48th Avenue, Long Island City 1, New York

Manufacturers of Fine Carbon Graphite Products including Carbon Specialties, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts
Distributors of 99.7% Pure Al_2O_3 Tubes and Crucibles

(Continued from page 32A)

New Products

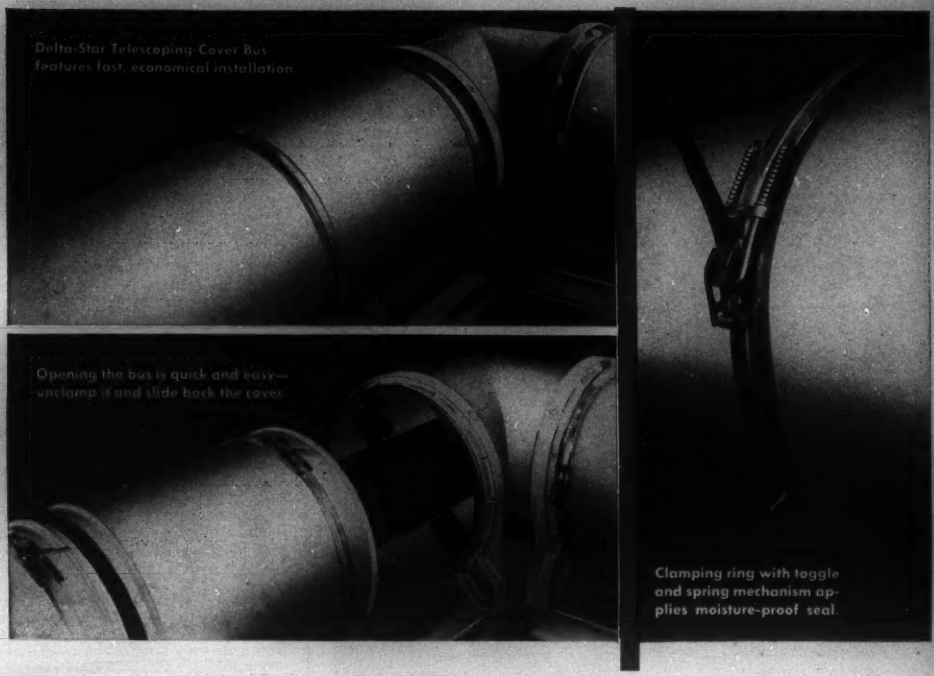
the new motor operated Model 65 Bon-Air furnace humidifier provides complete, automatic, mechanical atomization of fresh water. Designed for use on all types of forced warm air furnaces, the humidifier installs quickly and easily in the furnace plenum, duct, or counter flow furnace. There is no inventory problem because the Model 65 humidifier fits all applications. It operates quietly in conjunction with the furnace blower and provides humidification only when needed. Bon-Air's lifetime copper construction protects against corrosion, rust, pitting, and leakage. It is relatively service-free in operation since there is nothing more to buy, nor any evaporator plates to be replaced inasmuch as none are used.

Totally Enclosed Motor. A motor with facilities for mounting the driven equipment directly to the motor has been developed by U. S. Electrical Motors Inc., which is totally enclosed. Accurate alignment is provided by means of a totally enclosed, National Electrical Manufacturers Association (NEMA) style *C* bracket with tapped holes for bolting from the driven equipment side. Designed to the new dimension standard of NEMA, the motor has more horsepower in less space. Designated type *J*, the motor is available in ratings of 1 to 30 hp. For further information, write U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

Ground Station. A ground unit, designed to meet airline needs for compact, reliable, selective radio calling equipment, has been announced by Motorola, Inc., Communications and Electronics Division, 4501 W. Augusta Blvd., Chicago 51, Ill. The ground station combines tone generator, timer, power supply, and code selector elements in one compact unit.

It enables simultaneous signaling on several transmitters from a number of operator positions. This eliminates time lost waiting to use a common tone generator. Each position is entirely independent, eliminating interposition cabling. Code selection is made by means of push-buttons centered on a sloping-surface control panel.

(Continued on page 36A)


Delta-Star Telescoping-Cover Bus features fast, economical installation.
Opening the bus is quick and easy—unclamp it and slide back the cover.
Clamping ring with toggle and spring mechanism applies moisture-proof seal.

When you're thinking about cost reduction, check Delta-Star's Telescoping-Cover Bus

From installation to maintenance you reduce time and costs with Delta-Star's telescoping-cover isolated phase bus.

Installation is greatly simplified—for speed and economy. Longitudinal sections 6 to 8 ft. long can be pre-assembled and delivered in lengths as large as your facilities can handle. Telescoping covers clamp into position—are locked together with a toggle and spring clamping mechanism—no bolts needed. Clamping rings with fully-trapped, self-sealing neoprene gaskets make the bus as water-proof as it is possible for a gasketed bus to be. Gasketing is at a minimum—no longitudinal gaskets required.

Telescoping-cover bus sections can be opened and inspected without tools—*in just a few minutes.* A 2 ft. 6 in. opening allows ample room for inspection and cleaning.

Current-carrying ability and minimum-heating characteristics of the telescoping-cover bus proved out very well in tests and in use.

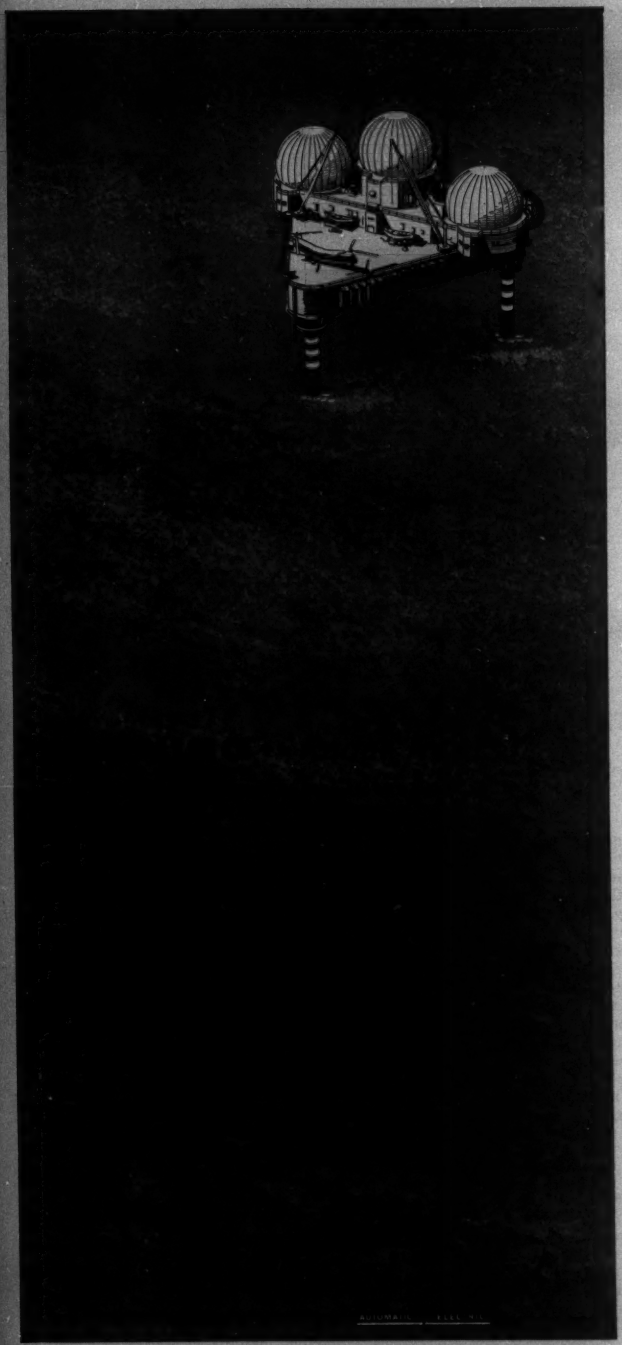
For your new bus runs—or replacements—be sure to check Delta-Star's telescoping-cover bus.

Delta-Star Electric Division
H. K. Porter Company, Inc.
Chicago 12, Illinois
District offices in principle cities

HKP DELTA-STAR ELECTRIC DIVISION

H. K. PORTER COMPANY, INC.

Divisions of H. K. Porter Company, Inc. are: Connors Steel, Delta-Star Electric, Henry Disston, Lacledе-Christy, Leschen Wire Rope, McLain Fire Brick, Quaker Rubber, Riverside-Alloy Metal, Vulcan Crucible Steel, W-S Fittings.



(Continued from page 34A)

New Products

Single Line Magnetic Shift Registers. These registers require only one shift pulse generator. They utilize one magnetic core and one germanium diode per stage with a vacuum tube driver, or one magnetic core and one transistor per stage with a transistor driver. Drivers can operate up to 50 stages of a register. Units are available at operating frequencies from 0 to 10kc, 50kc, 100kc, 250kc, and 500kc. They are used as a buffer storage in input–output equipment, serial and/or parallel shift registers, data and program storage, or for timing and counting circuits. These compact, low power, ultrareliable units have demonstrated life expectancies in excess of 40,000 hours. Normal packing density is 120 units per square foot of panel space for these rugged units. The magnetic core is encapsulated. The components are mounted on a printed circuit board which is sealed from outside moisture. The units are available with printed circuit lugs, solder lugs, or plug-in headers, and also custom-packaged to meet special requirements. They are manufactured by Mack Electronics, a Division of Mack Trucks, Inc., 40 Leon St., Boston 15, Mass.

Electronic Counter. An instrument manufactured by Gardner Laboratory, Inc., for measuring hardness of painted surfaces, provides greater accuracy by eliminating human errors and other variables that distort test results. Operation of the International Commission of Illumination (ICI) Automatic Sward Hardness Rocker depend on the number of times in a given interval a pendulum-like rocker oscillates over the surface being tested; the harder it is, the more oscillations. Automatic counting takes place as a shutter on the rocker interrupts a light beam, focused on a phototube in the counting circuit. Total interruptions or oscillations are presented digitally on a 4-digit register. Further information and specifications are contained in Bulletin No. *149*, available on request from Gardner Laboratory, Inc., Bethesda 14, Md.

Measuring Magnifier. This product is used for on-the-spot checks for linear dimensions, diameters, radii, and angles. Linear dimensions are given both in inches and millimeters. Measurements are made easily without the necessity for time-consuming adjustments. There are hundreds of uses for this measuring magnifier, also known as a pocket comparator, in industry, in the laboratory, and at the bench. The reticle can be easily removed so that the comparator becomes a high-power magnifier. Light is admitted to the object viewed through the transparent walls of the plastic cell at the bottom of the magnifier. This instrument gives 6-power magnification. Easily carried in the pocket, the Edmund measuring magnifier is ideal for checking and examining small parts. Available on direct order from Edmund Scientific Co., Barrington 21, N.J.

(Continued on page 40A)

"Time Teaches Many Lessons" *

*Aeschylus 540 B. C.

Ferdinand de Lesseps:

de Lesseps vision, the Panama Canal, inspired American engineers to titanic efforts—making the idea a reality. Tropical climate and terrain took a heavy toll in men and materials. But the lessons learned by a generation of canal builders—from 1882 to 1914—have never been forgotten.

In 1908, fifty miles of Kerite cable helped speed the completion of de Lesseps tremendous venture. Laid over jungle swamps and scarps, a thirty-mile length of this cable was submerged in the Gatun Lake. Based on the unfailing operation of the first cable, a second Kerite installation was completed in 1918. Time—more than 100 years of it—has taught successive generations of Kerite engineers that there can be no compromise with quality or integrity.

The value and service life of a product can be no greater than the integrity and craftsmanship of its maker.

Founded 1854

KERITE CABLE

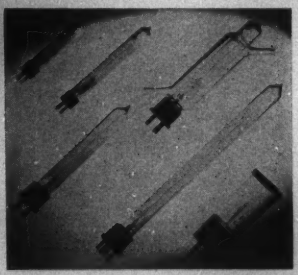
THE KERITE COMPANY—30 Church St., New York 7, N. Y.
Offices also at 122 S. Michigan Ave., Chicago; 582 Market St., San Francisco; 3901 San Fernando Rd., Glendale 4, Calif.; 31 St. James Ave., Boston; 4101 San Jacinto, Houston 4, Texas; 1010 Euclid Avenue, Cleveland 17, Ohio; 29 West Lancaster Avenue, Ardmore, Pa.

(Continued from page 36A)

New Products

Electrical Apparatus Valve. This valve, capable of draining all the oil from a transformer or circuit breaker, has been introduced by Ohio Brass Company. Because the body of the valve is offset below the mounting flange, the seat is actually ⅛ inch below the bottom level of the tank outlet when installed. Except for the shape of the body, the valve is similar to the company's current line of apparatus valves. Nylon is employed as the disc material on the basis of its excellent performance with all types of coolants. The valve can be ordered either with (No. *1941*) or without (No. *1942*) sampling device and is available in 1-inch, 1½-inch, and 2-inch sizes. For further information write to The Ohio Brass Company, Mansfield, Ohio, requesting data sheet *1384-V*.

Geiger Counters. Halogen quenched, all-glass geiger counters have been marketed at organic counter prices by Radiation Counter Laboratories. These low cost, all-glass tubes have infinite life and 20% higher gas counting efficiency than any other halogen counters. Neither light nor



extreme temperatures affect the characteristics of these nonphotosensitive tubes. The tubes come in six basic models: civil defense counter, thin wall for survey meters, thin wall jacketed, general purpose thin wall, long thin wall, and mica window counter. For more information, write: Radiation Counter Laboratories, Inc., Nucleonic Park, Skokie, Ill.

Custom Magnetic Heads. The Instrument Division of Thomas A. Edison Industries has developed a series of custom designed magnetic recording heads for use in computors in aircraft and industrial applications. Available in both single and multihead styles with up to 15 tracks, Edison magnetic heads are specially laminated for better high-frequency response. Track positions and straightness are held to extreme accuracies. Impedance between tracks is only ± 10% on standard units, ± 5% on custom units. Special specifications, including tailoring the head mounting, have been accomplished by Edison design engineers. For more complete information, write to Henry DeRosa, Instrument Division, Thomas A. Edison Industries, West Orange, N.J.

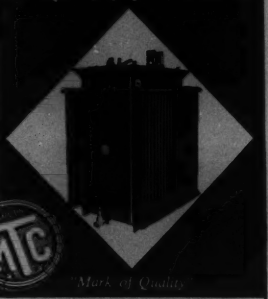
(Continued on page 46A)

DID MACY'S TELL GIMBELS

about those wonderful MARCUS transformers

We don't know . . . but both of these nationally famous department stores use Marcus Transformers for power and lighting distribution.

Marcus "Mark of Quality" transformers GUARANTEE trouble-free service and safe, dependable operation. For bigger profits and greater customer satisfaction, use MARCUS for your next installation.

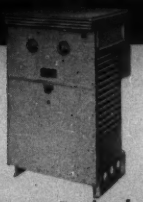


MARCUS
TRANSFORMER CO., Inc.
RAHWAY, NEW JERSEY
Representatives in Principal Cities

Mark of Quality

A COMPLETE LINE OF DRY TYPE AND LIQUID-FILLED TRANSFORMERS THRU 5000 KVA

NEW CHRISTIE SILICON POWER RECTIFIERS



For Top Reliability

- A standard line from 30 to 1000 amps
- Closely regulated by magnetic control
- Voltages: 8-16-32-36
- Stationary or Mobile Types
- For Missile, Aircraft, Lab & Factory

Write for Latest Bulletins on *Silicon & Selenium* Power Rectifiers

CHRISTIE ELECTRIC CORP.
Dept. EE, 3410 W. 67th St., Los Angeles 43
Over a Quarter Century of Rectifier Manufacturing

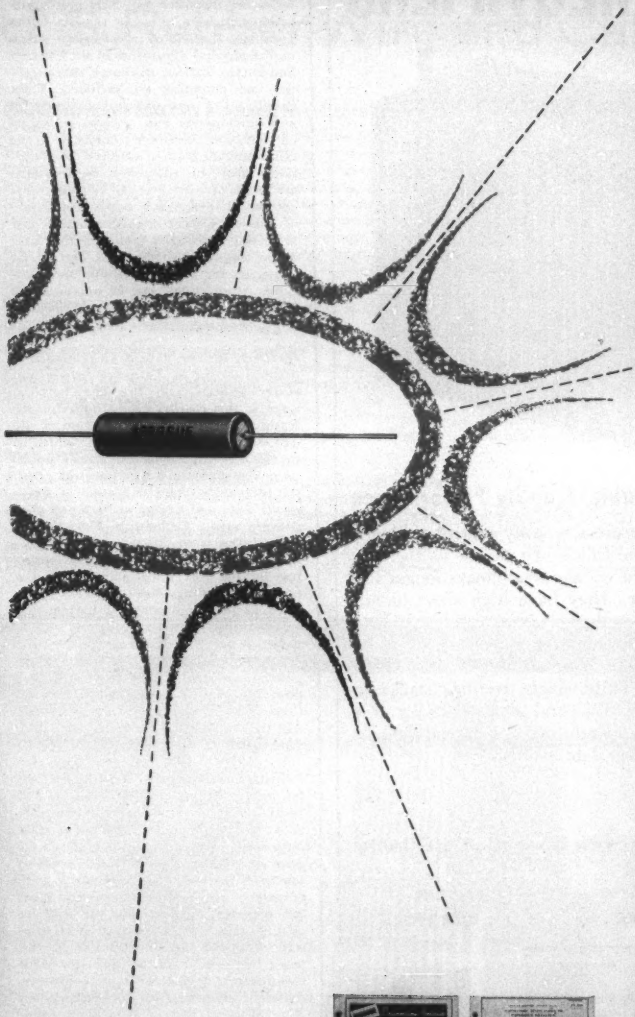
American Standard for POOL CATHODE MERCURY-ARC POWER CONVERTERS

Sponsored and published by AIEE, this standard (C34.1-1949), applies to all types of mercury-arc power converters, employing rectifying devices with mercury pool cathodes and used for power conversion purposes, including mercury-arc power rectifiers and inverters, electronic frequency changers and converters used with electronic motors when these equipments employ mercury-arc rectifying devices with pool cathodes. Price: $1.20.

Address: Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

4-57

Hyrel® *Q* the most reliable capacitors available anywhere!



The name "Hyrel" heralds a complete new line of Sprague Capacitors conforming to the most rigorous set of capacitor specifications ever written. Techniques, materials, and processes combine to make it the most reliable paper capacitor possible within the present state of the art. After two years of exhaustive pilot runs, these high reliability units are in high volume production *now*.

In missiles, jets, warning networks, computers, controls . . . *wherever reliability is important* . . . Hyrel Q capacitors find scores of applications. A glance at Sprague Specification PV-100 tells you why. It's far above and beyond commercial or present MIL military levels . . . and it calls for outstanding performance under high *g* shock, vibration, humidity, immersion, as well as under accelerated life test. Complete facilities for making every test called for have been installed in a special plant area in which Hyrel Q capacitors are manufactured by specially selected personnel.

The first Hyrel Q capacitors—Type 195P—are subminiature metal-clad paper units hermetically sealed with *compression*-type glass-to-metal solder-seal terminals. Available in both conventional tubular and screw-neck mounting styles, all are Vitamin Q impregnated and designed for operation from −55°C to +125°C. Voltage ratings of 200, 300, 400, and 600 VDC are standard.

Complete technical information is provided in Engineering Bulletin 2900 and Specification PV-100. Both are available on letterhead request to the Technical Literature Section, Sprague Electric Company, 321 Marshall St., North Adams, Mass.

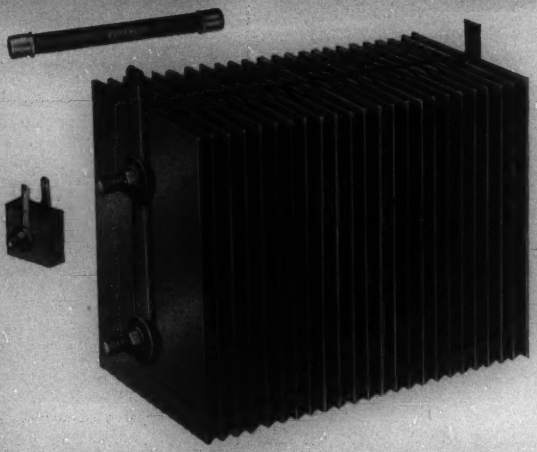
SPRAGUE®

the trademark of reliability

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • HIGH TEMPERATURE MAGNET WIRE • PULSE NETWORKS • PRINTED CIRCUITS

SYNTRON VACUUM PROCESS

SELENIUM RECTIFIERS



Proven by Years of dependable, Quality Performance

Syntron's unique vapor deposit process, quality control methods, and construction design provide rectifiers of extreme uniformity, and ruggedness. Their low forward voltage drop means longer life and lower operating temperature. They have high short circuit surge-current ability to 300 times their normal rating and can withstand high transient conditions without damage.

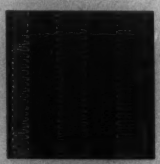
Syntron builds the largest variety of selenium cell sizes in the world. This permits Syntron to build single rectifier stacks to specifications. Eliminates the use of several smaller stacks in a series hook-up. Let our applications engineers recommend the best rectifier for you. Write for complete data—FREE

Other SYNTRON Equipment

of proven dependable Quality

VIBRATORY FEEDERS

SINUATED WIRE



BIN VIBRATORS

Write for complete catalogue—FREE

SYNTRON COMPANY

440 Lexington Avenue Homer City, Penna.

(Continued from page 40A)

TRADE LITERATURE

Batteries for Transistors. An engineering handbook section on the subject of batteries for transistor and electronic applications has been issued by the Ray-O-Vac Company. Individual specification sheets on the physical dimensions of the batteries and charts showing discharge characteristics and potentials are included. These details are of particular interest to design and development and research personnel and advanced electronic technicians in the radio and electronics industry. The relatively small current requirements associated with transistor radio and electronic equipment makes dry battery operation of this equipment highly desirable and increasingly popular. Copies of this Ray-O-Vac engineering handbook section on "Batteries for Transistor Radio and Electronic Applications" can be obtained free of charge by writing Ray-O-Vac Company, 212 E. Washington Ave., Madison 10, Wis.

Quarterly Review. Articles on construction progress on the St. Lawrence Seaway and power projects, and two new tugboats rated as this country's most powerful are features of the Winter 1957 issue of the ALCO Products Review. Also presented in the 26-page issue of the quarterly publication are stories on a new ammonia plant, the company's recent expansion at Beaumont, Tex., and a large utility's new electric generating facilities in Florida. The 6-page, illustrated article on the St. Lawrence work reports on construction progress on the vast undertaking. The new tugboats, the *Kings Point* and *Fells Point*, rated as the most powerful harbor tugs in the United States, are reported in a 5-page section. The boats are powered by Alco's 16-cylinder Model *251* diesel engines. These engines provide prime mover power through a reverse-reduction gear. Copies of the review are available from ALCO Products, Inc., P.O. Box 1065, Schenectady, N.Y.

Switchgear Components Test Unit. Used for testing relays, meters, coils, circuit breakers, etc., the type *RA1-1* Nelson portable relay test units may be used in combination for complete testing of switchgear components. Type *RD1-1* portable test units may be used for simple testing of meters, protective relays, overload heaters, tripping coils, etc. For use with a-c circuits, this unit is the first of its type sold. Prior to the development of this new equipment it was necessary for plant maintenance engineers to piece together the right equipment to test each device. Now all components of switchgear equipment can be tested properly and set with one piece of equipment. Each basic unit is light enough to be loaded and unloaded from the trunk of an automobile by one man. For further information write to Nelson Electric Manufacturing Company, P.O. Box 5385, Tulsa, Okla. and request Bulletin *774*.

(Continued on page 52A)

your questions

U. S. Rubber Wire and Cable Division

Q. Will new people from both companies be calling on me?

A. There will be no duplication of calls, because former U.S. Rubber personnel will be prepared to present the entire, broadened product line to those customers who can benefit by it. Occasionally, Kaiser Aluminum specialists will accompany the former U.S. Rubber representatives to help present the complete line. Conversely, Kaiser Aluminum Sales Representatives will be prepared to present the new, complete line to their established customers, assisted by former U.S. Rubber specialists.

Q. I formerly bought through a Kaiser Aluminum or U.S. Rubber distributor outlet. How will this be changed?

A. The distributor who formerly carried U.S. Rubber wire and cable will continue to offer the same products with no change. Present Kaiser Aluminum Distributor outlets also will remain unchanged.

Q. Will there be any effect on the Field Engineering Services formerly available through either company?

A. The technical assistance available to you will be greatly increased. Kaiser Aluminum—as the nation's largest producer of covered aluminum wire—is already a leader in research and product development, both in the laboratory and in the field. Now, by acquiring additional highly skilled technical personnel, these services will be further strengthened.

Q. How will the new setup affect my delivery date?

A. The convenience of a new eastern plant location, plus additional sales representatives and distributors, will mean even faster and more efficient service.

* * *

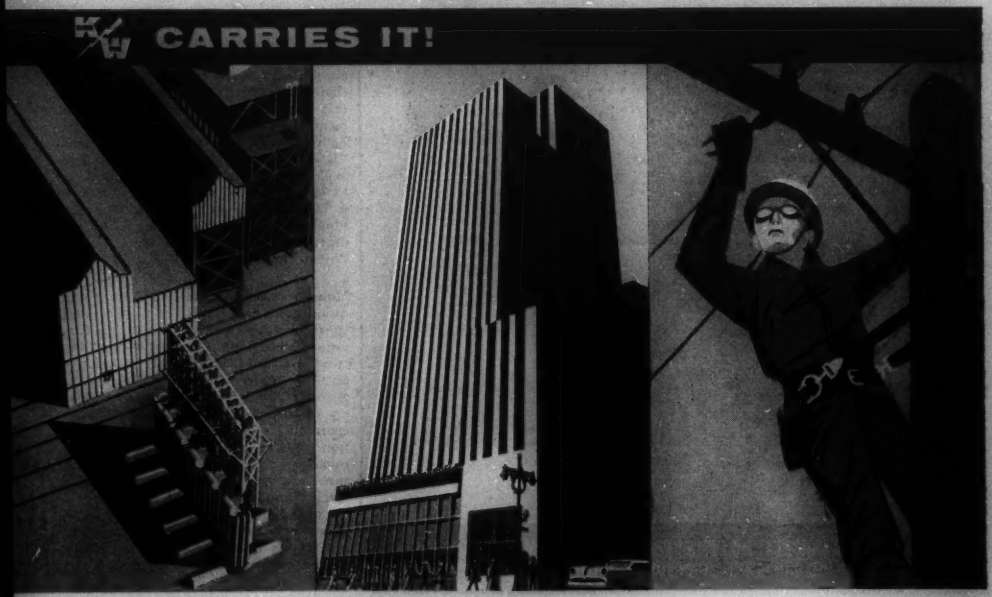
The purchase of the Wire and Cable Division of United States Rubber puts into operation the twenty-third plant for Kaiser Aluminum, which started with three plants just ten years ago.

This growth is based on the continued support of our customers, who, working with us, have helped to make Kaiser Aluminum the nation's fastest-growing major producer of aluminum. This latest acquisition represents another step forward in our program of complete service to the nation's rapidly-expanding electrical industry.

Kaiser Aluminum & Chemical Sales, Inc., *Executive Office*, Kaiser Bldg., Oakland 12, California; *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois.

Kaiser Aluminum

See "THE KAISER ALUMINUM HOUR." Alternate Tuesdays, NBC Network. Consult your local TV listing.



The Vacuum Switch Goes to Work

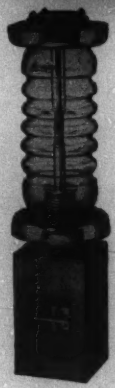
IN HIGH VOLTAGE DC CIRCUITS

Jennings RADIO

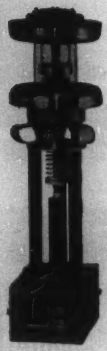
Years of experimentation and commercial usage have demonstrated that Jennings vacuum switches can interrupt many dc circuits that cannot be easily handled in any other way. They can "make" the high inrush currents that occur when capacitor banks are discharged and they can interrupt the fault currents that occur during the flashover of a power tube in a transmitter.

DC power supplies are now being switched "hot" from low power levels up to 250 kw under either normal or overload conditions. Overcurrent protection is excellent since operate times are only 4 to 10 milliseconds and deionization of the arc is extremely rapid in a high vacuum. Likewise, high voltage isolation, capacitor discharge, or safety grounding is easily accomplished with contact travels of no more than ⅛" regardless of voltage level. This makes possible solenoid actuating mechanisms that are simple in design and lend themselves to completely automatic operation.

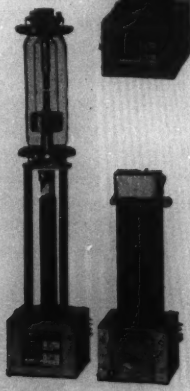
Please send us your circuit conditions. We can suggest vacuum switches that will solve most difficult dc switching problems.



TYPE RH7 85 kv N/C Grounding Relay



TYPE RH1G N/O for dc interruption up to 200 kw



TYPE R8G Overload Circuit Breaker

TYPE R1G N/O with 40 kv insulation

JENNINGS RADIO MANUFACTURING CORPORATION · 970 McLAUGHLIN AVE.
P.O. BOX 1278 · SAN JOSE 8, CALIFORNIA

(Continued from page 46A)

Trade Literature

"AN" Fastener Catalog. A 12-page catalog of stainless steel "AN" fasteners has been made available. Published by Allmetal Screw Products Co., Inc., manufacturer of stainless steel fasteners, it describes Government specification aircraft bolts, slotted and Phillips machine screws, flat and round rivets, and washers carried in stock. Illustrations, stock sizes, principal dimensions, and explanation of part and dash numbers are included for each item. Free copies may be obtained from Allmetal Screw Products Company, Inc., 821 Stewart Ave., Garden City, L.I., N. Y.

Servo Motor Bulletin. Complete information on standard and custom servo motors is offered to engineers in this bulletin. Data includes complete electrical and mechanical specifications, application data on direct plate-to-plate, transistorized servo amplifier, and magnetic servo amplifier applications. Norden-Ketay's standard servo motors are available in five frame sizes, complete ranges of input voltages, frequencies, and speeds. They enable design engineers to achieve rapid economical deliveries. Custom servo motors are available for special application with extra windings for feedback, with unbalanced input power (low control phase power input) or for high temperature use. Copies of Bulletin No. *385* are available from: Norden-Ketay Corporation, Commerce Road, Stamford, Conn.

Industrial Television. An 8-page descriptive brochure has been issued covering Philco Corporation's newly designed line of industrial television equipment. The booklet contains many illustrations of the latest developments in cameras, monitors, controls, lenses, and other accessories that are required to create any kind of camera chain. Included in the new line are cameras with full remote control for adjustment of focus and iris apertures and for both high and low speed tilt and pan. Also listed are special weatherproof and explosion-resistant housings as well as various lenses and turret heads. Write to: R. M. Fielding, Public Relations Manager, Philco Corporation, Government and Industrial Division, 4700 Wissahickon Ave., Philadelphia, Pa.

Motor Selection Manual. A 12-page, application guide that makes it easy to select electric motors for all popular applications has been published by Century Electric Company, 1806 Pine St., St. Louis 3, Mo. The reader selects from tables in the guide the kind of equipment or machinery to be driven. Then he identifies the character of the load, the speed of operation, starting and running torques, surrounding atmosphere, frame type, and speed to arrive at the right motor for his specific application. In a few moments, the reader knows the motor type he needs, dimensions, and other pertinent data. Free copies may be obtained by writing to the company for Application Guide No. *102*.